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USER'S GUIDE FOR A COMPUTER PROGRAM
TO ANALYZE THE LRC 16' TRANSONIC
DYNAMICS TUNNEL CABLE MOUNT SYSTEM
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Prepared under contract No. NAS1-10635-9 by
GRUMMAN AEROSPACE CORPORATION
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FOREWARD

This report is submitted to the NASA Langley Research Center in partial fulfillment of Master Agreement Contract NAS1-10635-9. This contract involves the formulation of a digital computing program to analyze the stability of models mounted on a two-cable mount system used in the LRC 16' transonic dynamics tunnel.

Mr. R. M. Bennett of the NASA Langley Research Center is the technical monitor. Mr. Eugene Baird of the Grumman Aerospace Corporation is the master agreement program manager, and Mr. Paul Barbero of Grumman is the project manager.

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SYMBOLS

a_c	coulomb friction static force
AKR	rear cable spring constant
b	wing span (reference)
\bar{c}	wing chord (reference)
C_D	drag coefficient (stability axis)
CG	referenced to center of gravity
C_l	rolling moment coefficient
C_L	left coefficient (stability axis)
C_m	pitching moment coefficient
C_{m_p}	rotational damping coefficient
C_n	yawing moment coefficient
CR	referenced to equation reference center
C_x	x force coefficient (body axis)
C_y	side force coefficient
C_z	z force coefficient (body axis)
F_x, F_y, F_z	external forces on model
\bar{g}	acceleration due to gravity
I_{ab}	inertias with respect to axis a, b at the equation reference center
$I_{ab_{CG}}$	inertias with respect to axis a, b at the center of gravity
K_{A_z}	vertical acceleration feedback gain
K_{ϕ}	roll rate feedback gain
K_y	yaw rate feedback gain
K_{θ}	pitch rate feedback gain
m	model mass
N_p	pulley normal force
p, P	model roll rate

q, Q	model pitch rate
\bar{q}	dynamic pressure
r, R	model yaw rate
S	model reference wing area
T	cable tension
T_F	front cable tension
T_R	rear cable tension
V_o	tunnel velocity
W	model weight
M, N, L	external moments on model
x, y, z	displacement coordinates of model
ϕ, θ, ψ	angular rotations around x, y and z axis respectively
α	angle of attack
α_{cd}	direction cosine between flying cable c and body axis d
β	angle of sideslip
δ_ω	roll control deflection
δ_e	pitch control deflection
δ_r	yaw control deflection
δ_a	roll control deflection
ω	model rotational rates
ζ	tunnel density

Stability derivatives are indicated by subscript notation. For example:

$$C_{L_\alpha} = \partial C_L / \partial \alpha$$

$$C_{n_p} = \partial C_n / \partial (pb/2V_o)$$

(see section 11.1, description of array AERO)

1.0 INTRODUCTION

In accordance with the requirements set forth under NASA Master Agreement NAS1-10635, Development and Implementation of Space Shuttle Structural Dynamics Modeling Technology-Task Order Number 9, Cable Mount System Study for Space Shuttle, the following report is submitted.

Contained in this report is a discussion of the theoretical derivation of the set of equations applicable to modeling the dynamic characteristics of aeroelastically-scaled models 'flown' on the two-cable mount system in the Langley Research Center 16' transonic dynamics tunnel. Also contained herein is a description of the computer program provided for the analysis.

The program will calculate model trim conditions as well as 3 DOF longitudinal and lateral/directional dynamic conditions for various flying cable and snubber cable configurations. Sample input and output is contained in Appendix B and C.

2.0 GENERAL PROGRAM DESCRIPTION

The digital computer program described in this report is used to analyze the rigid body stability and trim characteristics of models mounted on a 'two-cable mount system' presently used in the Langley Research Center 16' Transonic Dynamics Tunnel. The program is so structured as to allow model, tunnel and cable system parameters to be varied independently in order that their effects on model stability can be analyzed.

All program options, theoretical derivations, and data input formats will be explained in the body of this report. The following items are of special interest and will be explained in detail in the report:

- The trim routine will predict model angle of attack, pitch control deflection and all cable tensions and angles for any tunnel condition of interest to the investigator.
- Stability analysis is accomplished using 2 sets of 3 DOF uncoupled longitudinal and lateral/directional perturbation equations modeling both model aerodynamic effects and cable effects.
- Included in the stability analysis is the ability to investigate the effects of automatic stabilization using model stability augmentation. The general feedback loops provided allow stabilization using pitch, roll and yaw rate feedbacks to yaw, pitch and roll moment generators in the model.
- A root locus feature is built into the program allowing for automatic variation of any input parameter, producing trim variations plus a locus of roots for the longitudinal and/or lateral/directional dynamics.
- Four general cable configurations are included in the analysis: front and rear cables vertical, front and rear cables horizontal, front cable vertical and rear cable horizontal, front cable horizontal and rear cable vertical.

- The effects of both snubbed and unsnubbed snubbers on trim and stability have been included. The general snubber arrangement is a double 'V' shown in Figure 11.3. However, proper selection of input data will convert the snubber model into any snubber configuration presently envisioned.
- Provisions have been made to include the effects of one additional cable attached anywhere on the model.
- All aerodynamic data for the model is input in stability axis as 'point data' at a given mach number or as 'table data' where all coefficients are input across the mach number range in interest.
- All cable tie-down locations and model position are input in tunnel coordinates (station, water line, butt line).
- Normal program output includes the trim condition, the roots of the characteristic equations (longitudinal and/or lateral/directional), damped natural frequency and damping ratio for each pair of complex roots and the time to half amplitude for real roots. Additional program output, as a user option, is included for debugging purposes.

2.1 MAJOR PROGRAM SUBROUTINES

A general flow chart of the program is shown in Figure 2.1. The following comments are made in reference to that chart.

All input data for the initial case is read in first (input format described in Section 11). If table data is to be used, it must be read in on the first pass. If root locus is to be used, the proper value of the parameter to be varied is calculated in subroutine RUTLOC. The next step is to transform the input inertia and aerodynamic data to the equation reference axis in subroutine TRAN1 (Section 3.1 and 3.2). The model is then trimmed in subroutine TRIM described in Section 4.0. After completing the trim, the aero data is transformed to body axis in subroutine TRANS described in Section 3.3. Depending on the option selected by the user

either longitudinal or lateral/directional or both stability calculations are made. These calculations are contained in subroutines LONG and LAT which are discussed in Sections 6.0 and 7.0. Upon returning from these subroutines, the root locus routine is entered if a parameter variation is in progress or a new case is initiated. Input data for a new case is discussed in Section 11.0.

The subroutines formulated to handle snubber effects (SNTRM, LONGSN, LATSN) are called from within the TRIM, LONG and LAT routines and are discussed in Section 8.0.

A description of the three main subprograms, TRIM, LONG, LAT, and their supporting subprograms are presented in Sections 4, 6, and 7 respectively. The format used is a brief description of the purpose, the theory, some pertinent equations and a functional flow diagram for each subroutine. An exception to this approach is the theoretical development of the perturbation equations and the cable influence coefficient matrix. The development of the theory and equations in generalized form are presented in Section 5.

The particular applications of these generalized equations to the longitudinal and lateral directional analysis are then discussed in Sections 6 and 7 respectively.

The axis system used throughout the study is a conventional right-handed body axis fixed to the model with the origin at a point called the center of reference (cr). The positive x axis points forward out the nose of the model and the positive y axis is out the right wing. Figure 2.2 shows the axis system and a nomenclature of the various cable constraints.

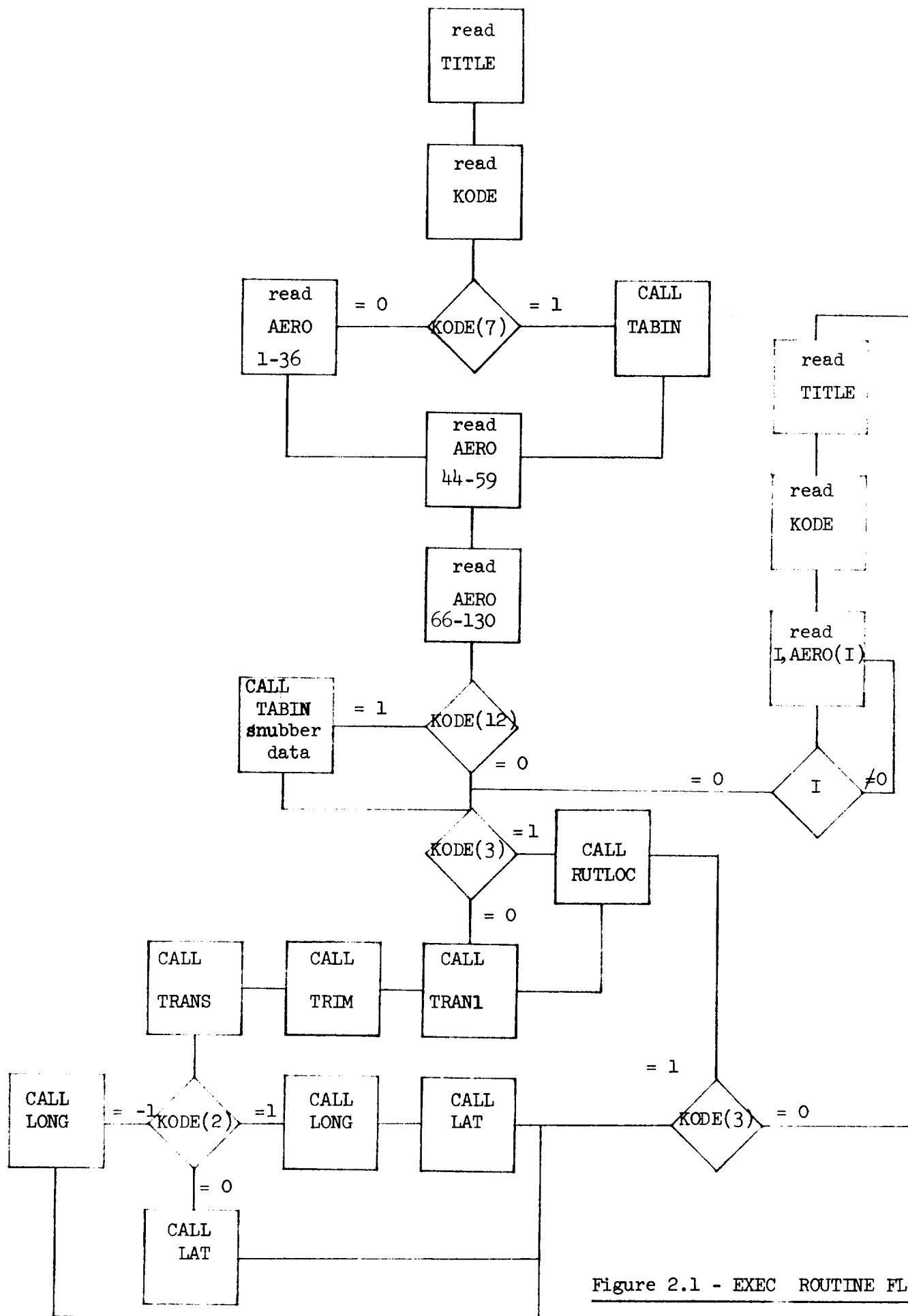
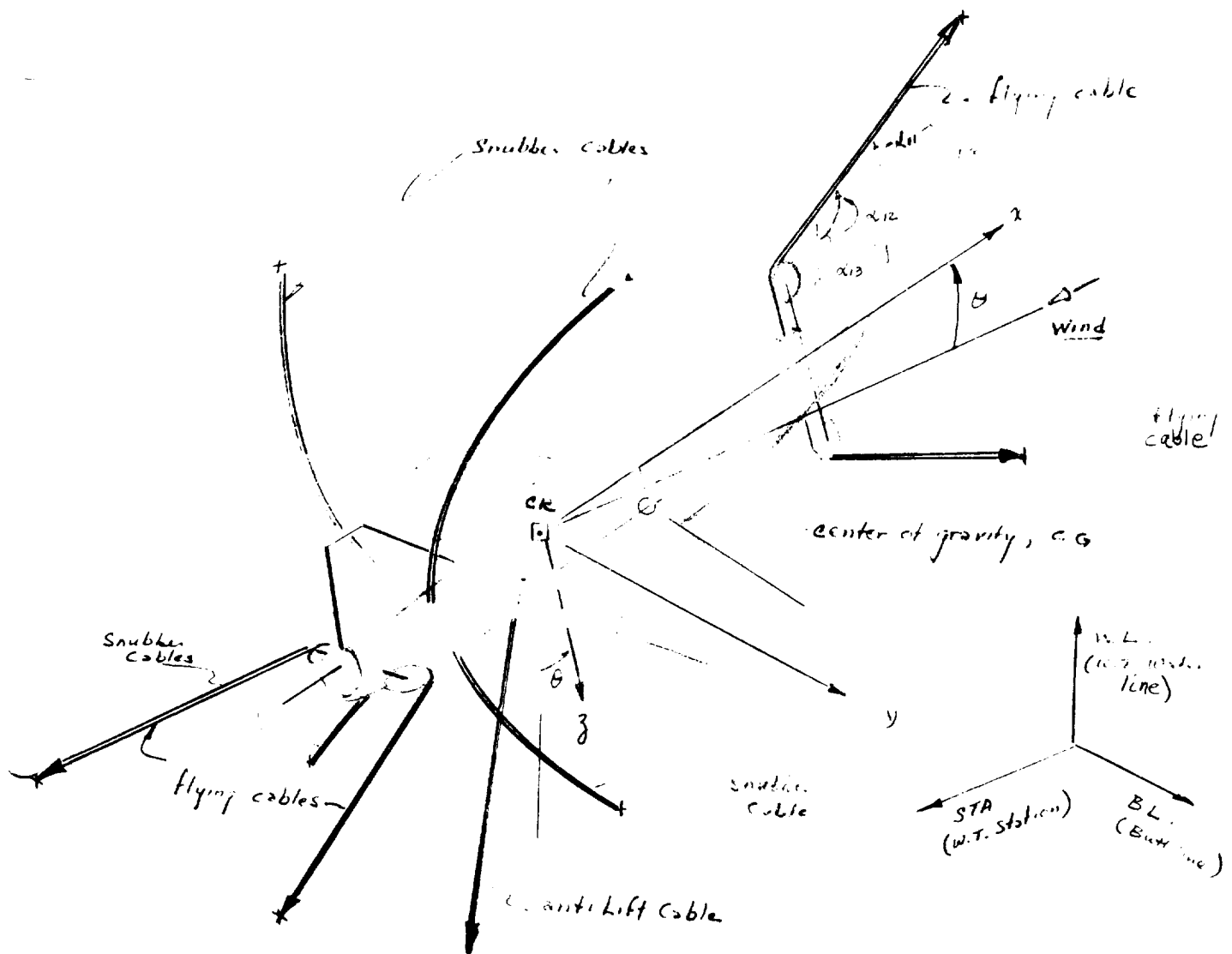


Figure 2.1 - EXEC ROUTINE FLOW CHART



- STA, WL, BL - wind tunnel coordinates ~ stations (inches), water line (inches), butt line (inches)
- x, y, z - body axis - fixed to the body
- α (IC, J) - direction cosine angles, IC defines the cable and J defines the axis. e.g. α_{13} is the direction cosine angle from the z axis to the number 1 cable.
- cr - origin of the body axis system, center of reference
- C.G. - center of gravity

FIG. 2.2; AXIS AND CABLE DEFINITION

3.0 INERTIA AND AERODYNAMIC DERIVATIVE TRANSFORMATIONS

The program provides for general placement of the model mass center of gravity and the aerodynamic reference point. All force and moment equations have been written around the equation reference center which is located in terms of tunnel coordinates (STACR, WLCR, BLCR). All other reference points (center of gravity and aerodynamic reference) and pulley positions are located with respect to the reference center.

Since all equations are written with respect to the reference center, the inertias and aerodynamic data must be transformed to this center. This is done in subroutine TRAN1.

In addition to a reference center transformation, the aerodynamic derivatives must be transformed from stability to body axis. This is accomplished in subroutine TRANS.

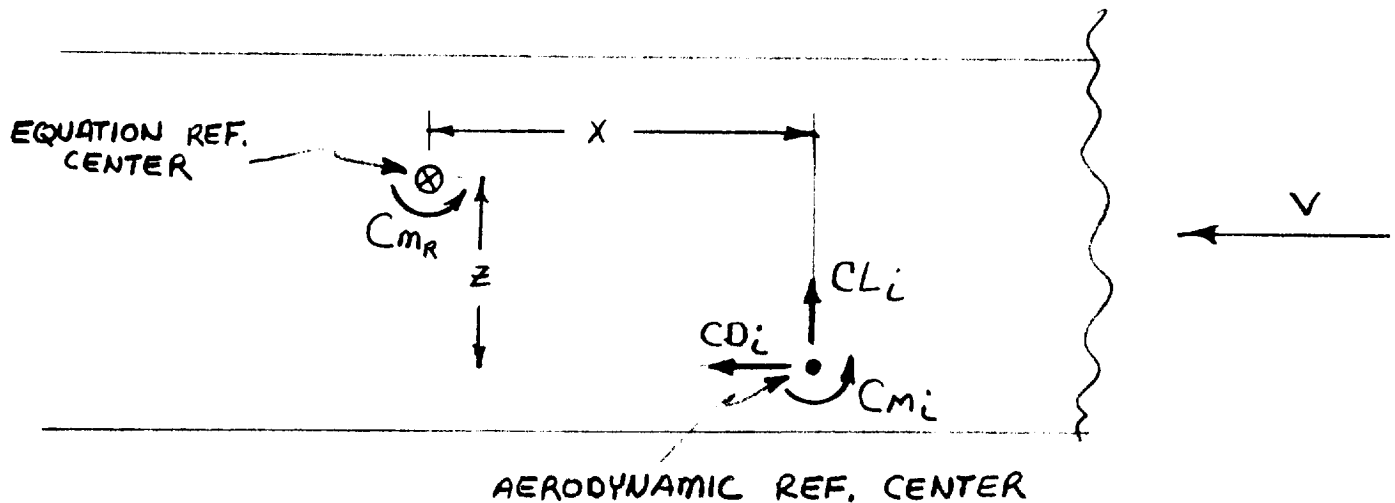
3.1 INERTIA TRANSFORMATION

The classic inertia transformations, assuming constant model density, are used to transform mass moment of inertias from the center of gravity (inertias are input as body axis values at the center of gravity) to the equation reference center. The axis systems at the center of gravity and the equation reference center are parallel (both lie along the x-body axis) requiring only a translational transformation. It is also assumed that there is no lateral displacement between the center of gravity and the equation reference center. The resulting equations shown below are modeled in subroutine TRAN1 (Figure 3.1).

$$\begin{aligned} I_{xx} &= I_{xx_{C.G.}} + x^2 m & I_{zz} &= I_{zz_{C.G.}} + z^2 m \\ I_{yy} &= I_{yy_{C.G.}} + (x^2 + z^2) m & I_{xz} &= I_{xz_{C.G.}} - xzm \end{aligned}$$

3.2 AERODYNAMIC REFERENCE TRANSFORMATION (Translation)

All aerodynamic moment effects must be transformed to the reference center. The following general theory is used in subroutine TRAN1 to accomplish the transformation.



Referring to the above figure:

$$Cm_R = Cm_i - \frac{z}{c} CD_i + \frac{x}{c} CL_i$$

A similar situation exists for lateral and directional moment derivatives.

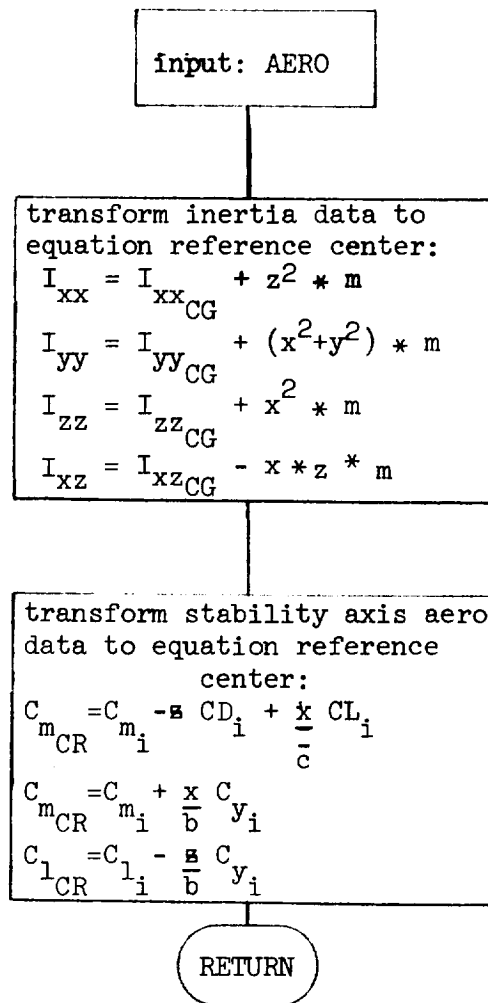
$$Cn_R = Cn_i + \frac{x}{b} Cy_i$$

$$Cl_R = Cl_i - \frac{z}{b} Cy_i$$

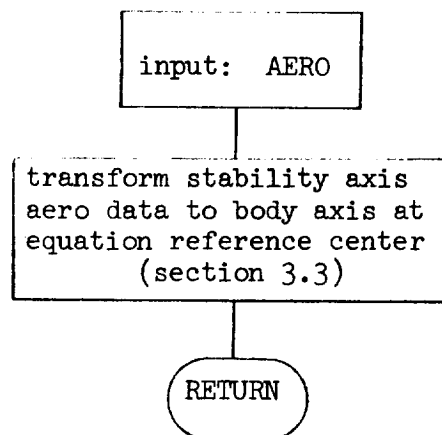
The force derivatives are not effected by a translational shift in axis systems.

3.3 AERODYNAMIC TRANSFORMATION FROM STABILITY TO BODY AXIS (Rotational)

Once the aero data is referenced to the reference center it is then transformed from the stability axis input form to the body axis form necessary for stability calculations. This is accomplished in subroutine TRANS. The transformation equations were taken directly from 'Aircraft Motion Analysis' by Thelander, pgs. 57-58. A flow chart of subroutine TRANS is shown in Figure 3.1.



SUBROUTINE TRAN1



SUBROUTINE TRANS

FIGURE 3.1 - FLOW CHART - TRAN1 AND TRANS

4.0 TRIM ANALYSIS

4.1 Subroutine TRIM

The function of this subprogram is to determine the vehicle trim attitude for a given initial rear cable tension, T_{R0} . The outputs of the program are the trim attitude, θ , trim elevator deflection, δ_e , and the geometry and tensions of the flying and antilift cable system. The model may be trimmed at any water line and station specified. The equation reference center (STACR, WLCR) is used to position the model in the tunnel.

The subprogram defines trim as the point where the following three requirements on the longitudinal equations of motion are satisfied:

$$\begin{aligned}a_z &= \frac{1}{m} \Sigma F_z = 0 \\a_x &= \frac{1}{m} \Sigma F_x = 0 \\ \ddot{\theta} &= \frac{1}{I_y} \Sigma M_y = 0\end{aligned} \quad (4.1 - 1)$$

The variables in this set of equations are θ , δ_e and T_F , the front cable tension. The T_F is a variable because the front cable is fixed in length and the tension must necessarily adjust to satisfy the constraint.

A numerical iterative technique is used to trim the system of cable and model forces. The procedure is based on the following formulation for convergence.

The forces and moments of equation 4.1-1 are expanded using the Taylor's expansion:

$$\begin{aligned}\Sigma F_z &= F_{z0} + \frac{\partial F_z}{\partial \theta} \Delta \theta + \frac{\partial F_z}{\partial \delta_e} \Delta \delta_e + \frac{\partial F_z}{\partial T_F} \Delta T_F \\ \Sigma F_x &= F_{x0} + \frac{\partial F_x}{\partial \theta} \Delta \theta + \frac{\partial F_x}{\partial \delta_e} \Delta \delta_e + \frac{\partial F_x}{\partial T_F} \Delta T_F \\ \Sigma M_y &= M_{y0} + \frac{\partial M_y}{\partial \theta} \Delta \theta + \frac{\partial M_y}{\partial \delta_e} \Delta \delta_e + \frac{\partial M_y}{\partial T_F} \Delta T_F\end{aligned} \quad (4.1-2)$$

Equation 4.1-2 must be equated to zero to satisfy trim.

$$\begin{bmatrix} \frac{\partial F'_z}{\partial \alpha} & \frac{\partial F'_z}{\partial \delta_e} & \frac{\partial F'_z}{\partial T_F} \\ \frac{\partial F'_x}{\partial \alpha} & \frac{\partial F'_x}{\partial \delta_e} & \frac{\partial F'_x}{\partial T_F} \\ \frac{\partial M'_y}{\partial \alpha} & \frac{\partial M'_y}{\partial \delta_e} & \frac{\partial M'_y}{\partial T_F} \end{bmatrix} \begin{pmatrix} \Delta \theta \\ \Delta \delta_e \\ \Delta T_F \end{pmatrix} = [A] \begin{pmatrix} \Delta \theta \\ \Delta \delta_e \\ \Delta T_F \end{pmatrix} = \begin{pmatrix} -F_{zo} \\ -F_{xo} \\ -M_{yo} \end{pmatrix} \quad (4.1-3)$$

Inverting matrix A will define the required incremental change to the variables θ , δ_e , and T_F to satisfy trim. i.e.

$$\begin{pmatrix} \Delta \theta \\ \Delta \delta_e \\ \Delta T_F \end{pmatrix} = [A]^{-1} \begin{pmatrix} -F_{zo} \\ -F_{xo} \\ -M_{yo} \end{pmatrix} \quad (4.1-4)$$

The logic in the TRIM subprogram, shown in Figure 4.1, is to compute the initial forces and moments (F_{zo} , F_{xo} , M_{yo}), and determine whether the trim requirement, is satisfied.

If not, the program computes the set of partials in eq. 4.1-3, inverts the matrix A and determines the increments $\Delta \theta$, $\Delta \delta_e$, and ΔT_F . The variables are modified and the forces and moments recomputed.

The Model is assumed to remain stationary in translation during the trim procedure. This assumption violates the constant front cable length constraint, however, the translation associated with attitude changes is negligible relative to the overall front cable length.

If the trim requirement has not been satisfied after 100 iteration cycles, the TRIM subprogram will print out a note to this effect and the last set of θ , δ_e and T_F is assumed in the continuation of the program.

4.2 Subroutine EQU

This subprogram is called by the subroutine TRIM. Its function is to generate the longitudinal forces and moments. Each time this routine is called, it establishes the cable geometry, then computes and sums the force and moment contributions due to aerodynamics, vehicle weight and the system of cables.

The input to this subprogram are the variables θ , δ_e and T_F . The basic equations are:

$$\begin{aligned}
 \Sigma F_z &= F_{z_{aero}} + F_{z_{front\ cable}} + F_{z_{rear\ cable}} \\
 &\quad + F_{z_{anti-lift\ cable}} + F_{z_{snubber}} + W * \cos \theta \\
 \Sigma F_x &= F_{x_{aero}} + F_{x_{front\ cable}} + F_{x_{rear\ cable}} \\
 &\quad + F_{x_{anti-lift\ cable}} + F_{x_{snubber}} - W * \sin \theta \\
 \Sigma M_y &= M_{y_{aero}} + M_{y_{front\ cable}} + M_{y_{rear\ cable}} \\
 &\quad + M_{y_{anti-lift\ cable}} + M_{y_{snubber}} + M_{y_{wgt}}
 \end{aligned} \tag{4.2-1}$$

The contribution, $M_{y_{wgt}}$, shown here is a necessary term since the moments are taken about a point other than the center of gravity location.

The aerodynamic forces and moment are determined as follow:

$$\begin{aligned}
 \text{Lift} = L &= qS(C_{L_o} + C_{L_\alpha} \theta + C_{L_{\delta_e}} \delta_e) \\
 \text{Drag} = D &= qS(C_{D_o} + C_{D_\alpha} \theta + C_{D_{\delta_e}} \delta_e) \\
 F_{z_{aero}} &= -(L \cos \theta + D \sin \theta) \\
 F_{x_{aero}} &= -(D \cos - L \sin \theta) \\
 M_{y_{aero}} &= qS\bar{c}(C_{m_o} + C_{m_\alpha} \alpha + C_{m_{\delta_e}} \delta_e)
 \end{aligned} \tag{4.2-2}$$

The anti-lift cable forces and moments are determined by computing the forces in the wind tunnel axis (an axis aligned with the wind tunnel) and then transforming them to the rotated body axis. Along the wind tunnel axis, the F_{xt} and F_{zt} are computed as follows:

$$F_{zt} = F_{ZLTT} = TLFT * \cos \alpha_{ZWT} \quad (4.2-3.1)$$

$$F_{xt} = F_{XLTT} = TLFT * \cos \alpha_{XWT}$$

where α_{WT} are direction cosine with respect to the wind axis and TLFT is the anti-lift cable tension force defined by the equation:

$$TLFT = T_{LFTO} + AKLFT (l - l_o) \quad (4.2-3.2)$$

AKLFT here is the spring constant, T_{LFTO} is the initial tension corresponding to initial cable length, l_o . Converting these forces to the body axis we have:

$$\begin{aligned} F_{x \text{ anti-lift}} &= F_{xt} \cos \theta - F_{zt} \sin \theta \\ F_{z \text{ anti-lift}} &= F_{zt} \cos \theta - F_{xt} \sin \theta \end{aligned} \quad (4.2-4.1)$$

The anti-lift cable moment is easily obtained since the attachment point relative to the center of reference is known (ALT_X , ALT_Z). Thus:

$$M_{y \text{ anti-lift}} = F_{x \text{ anti-lift}} * ALT_Z - F_{z \text{ anti-lift}} * ALT_X \quad (4.2-4.2)$$

The flying cable forces and moments along the body axis are directly computed since the direction cosines between each cable and the body axis were computed in subprograms FPLYV and RPLYH. Thus:

$$\begin{aligned} F_{X_F} &= T_F (\cos \alpha_{11} + \cos \alpha_{21}) \\ F_{Z_F} &= T_F (\cos \alpha_{13} + \cos \alpha_{23}) \\ F_{X_R} &= T_R (\cos \alpha_{31} + \cos \alpha_{41}) \\ F_{Z_R} &= T_R (\cos \alpha_{33} + \cos \alpha_{43}) \end{aligned} \quad (4.2-5.1)$$

The subscripts of the direction cosine refer to the cable and the axis in question. The two front flying cables are

designated as 1 and 2 and the two aft flying cables are designated as 3 and 4. The body axis x, y, z is referred to numerically as 1, 2, and 3. Thus $\cos \alpha_{13}$ is the direction cosine of the number one front cable with respect to the z-body axis. The rear tension force, T_R , is defined by the following equation.

$$T_R = T_{Ro} + AKR (\ell_R - \ell_{Ro}) \quad (4.2-5.2)$$

where T_{Ro} is the initial cable tension corresponding to ℓ_{Ro} , ℓ_{Ro} being the summation of the initial lengths of cables 3 and 4. AKR and ℓ_R are respectively the rear cable spring constant and the instantaneous summed cable lengths of cables 3 and 4.

A derivation of the generalized cable force and moment is presented in Section 5.4.

The flying cable moments are obtained via the following equation:

$$M_{\text{cable}} = \sum_{i=1}^4 \bar{x}_i * \bar{F}_i \quad (4.2-6)$$

where \bar{x}_i corresponds to the moment arm from the center of rotation to the point of action of the force \bar{F} . The components of \bar{x}_i are computed in subroutines FPLYV and RPLYH.

Figure 4.2 presents a functional flow diagram of the subroutine EQU.

4.3 SUBROUTINE FPLYV

The function of this subroutine is to compute the geometry of a set of vertically configured flying cables.

The inputs to this program are:

1. The location of the cable attachment points to the wind tunnel wall
2. The location of the vehicle in the tunnel
3. The vehicle attitude
4. The pulley size
5. The pulley location on the model

The outputs of this program are the following geometric information for the upper and lower cables:

1. A set of direction cosine angles defining the cable orientation in space relative to the body axis (noted as ADC in the program)
2. A set of coordinates locating the point of action of the cable tension force (noted as ARM in the program)
3. The cable length (noted as XLGTH in the program)

Figure 4.3 defines the geometric nomenclature and some of the equations in the subroutine. The equations show the derivation for the cable length and the angle BETAU for the upper cable. Similar computation will define the length and the angle BETAL of the lower cable. Direction cosine angles of each of these cables can be derived from the angles BETAU, BETAL and the vehicle attitude θ . The coordinates of the point of action are also readily computed. The equations for the upper front cable are presented as an example.

Direction Cosines:

$$\begin{aligned}\alpha_{1x} &= \text{ADC}(1,1) = -\theta_u + \theta \\ \alpha_{1y} &= \text{ADC}(1,2) = \pi/2 \\ \alpha_{1z} &= \text{ADC}(1,3) = \pi/2 - \alpha_{1x}\end{aligned}\tag{4.3-1}$$

Point of Action:

$$\begin{aligned}x_p &= \text{ARM}(1,1) = EP - \text{RAD} * \sin \alpha_{1x} \\ y_p &= \text{ARM}(1,2) = 0 \\ z_p &= \text{ARM}(1,3) = HU + \text{RAD} * \cos \alpha_{1x}\end{aligned}\tag{4.3-2}$$

A functional flow diagram of this subroutine is presented in Figure 4.4.

The purpose of this subroutine is to define the geometry of a set of horizontally configured flying cables.

The inputs required for this subroutine are:

1. The location of the cable attachment points to the wind tunnel wall
2. The location of the model in the tunnel
3. The attitude of the model
4. The pulley size
5. The pulley location on the model

The output of this program is the following geometric information for each of the port and starboard flying cables.

1. A set of direction cosine angles defining the cable orientation with respect to the model body axis (noted as ADC in the program)
2. A set of coordinates locating the cable force point of action (noted as ARM in the program)
3. The cable length (noted as XLGTH)

Figure 4.5 defines the geometric nomenclature used in this subroutine. Figure 4.6 presents a functional flow chart of the program logic.

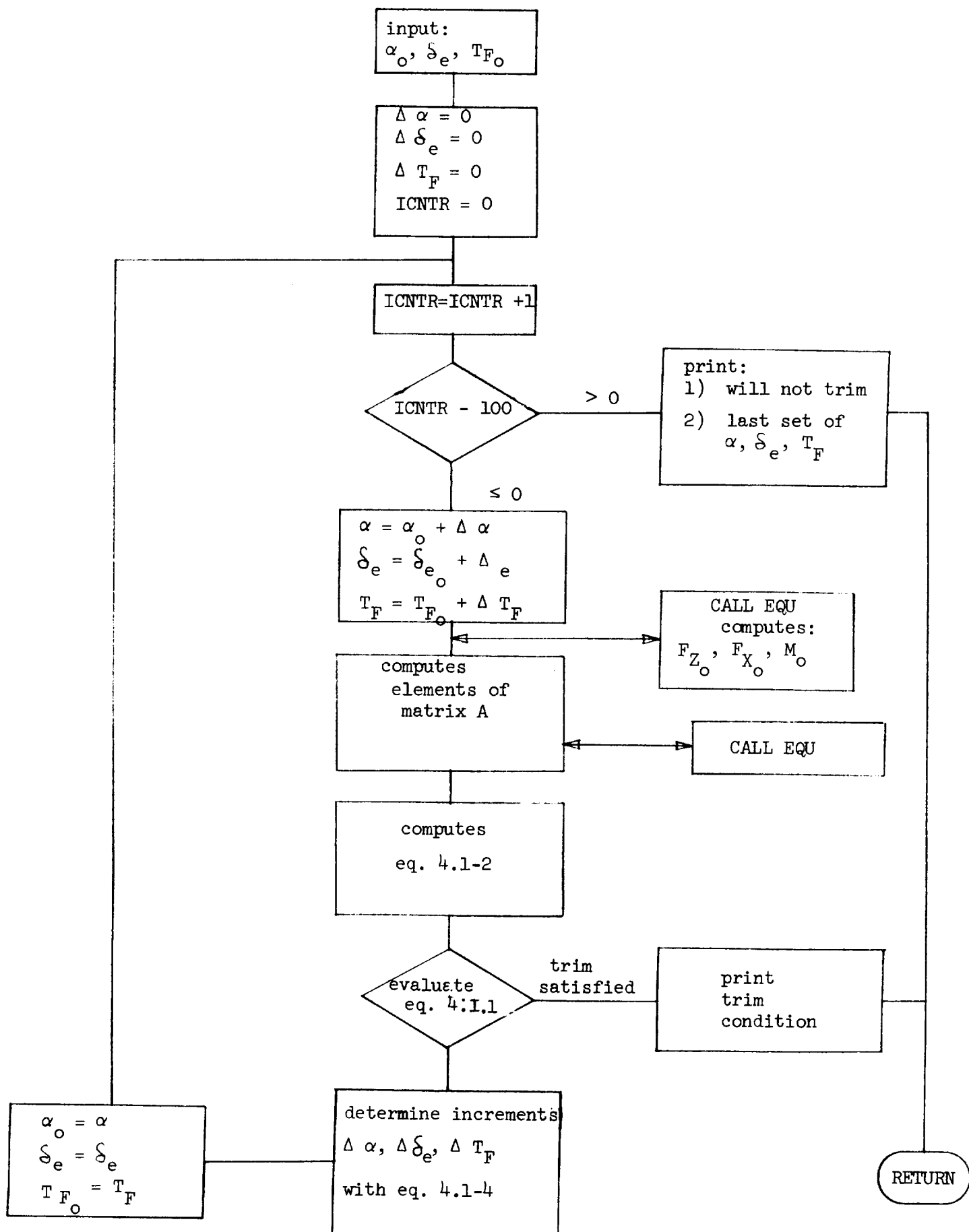


FIGURE 4.1 - FLOW CHART - SUBROUTINE TRIM

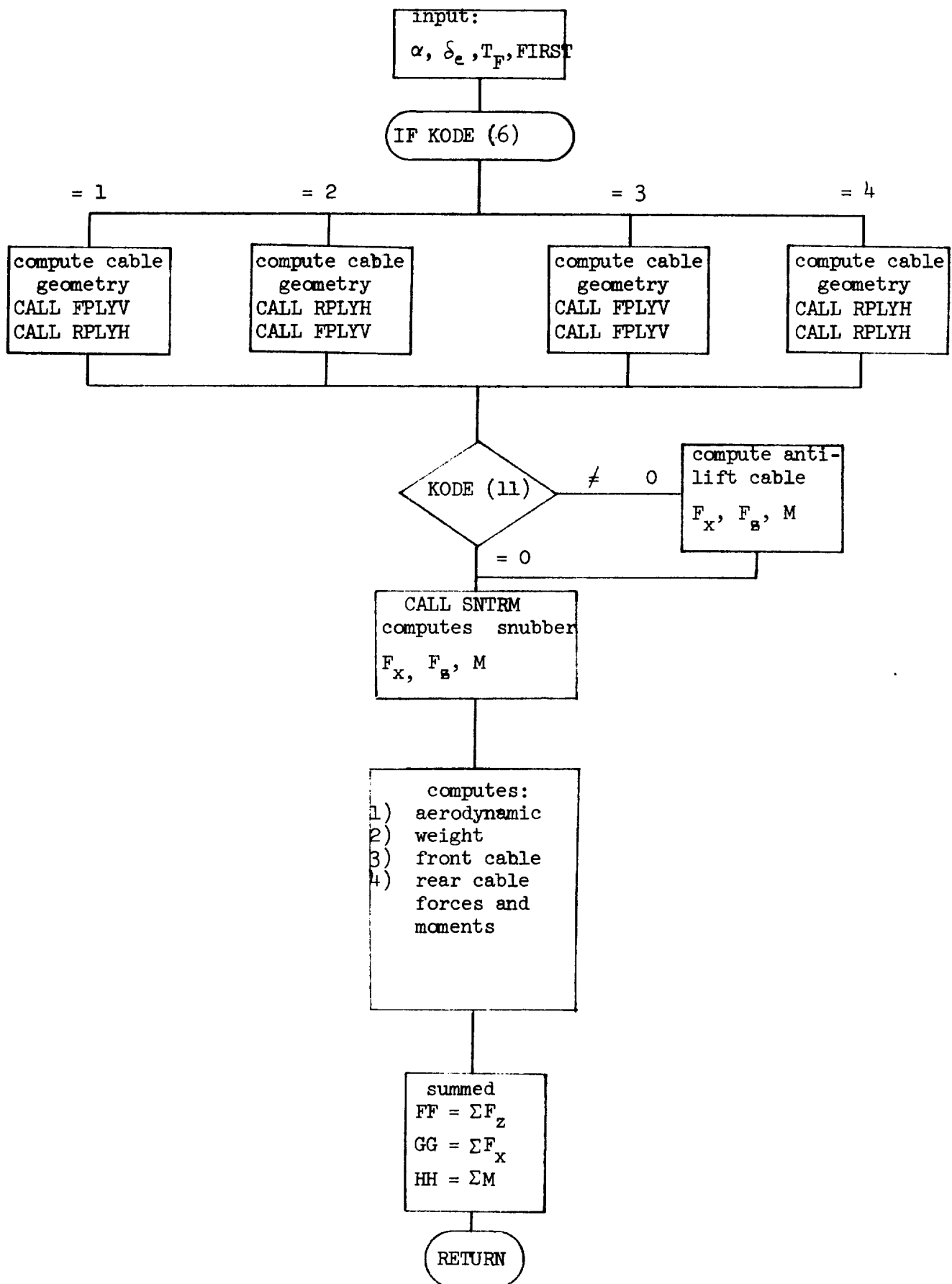


FIGURE 4.2 - FLOW CHART - SUBROUTINE EQU

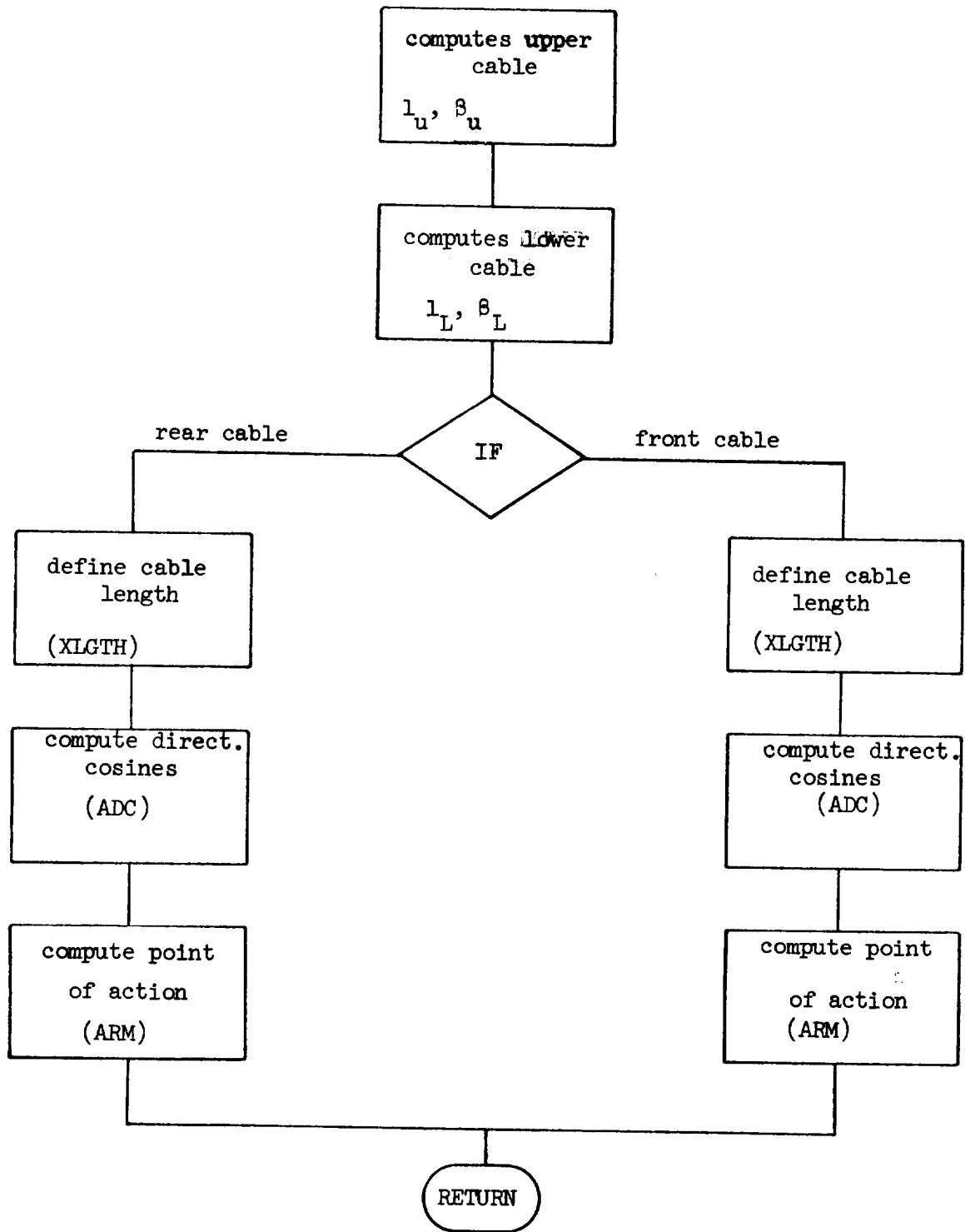
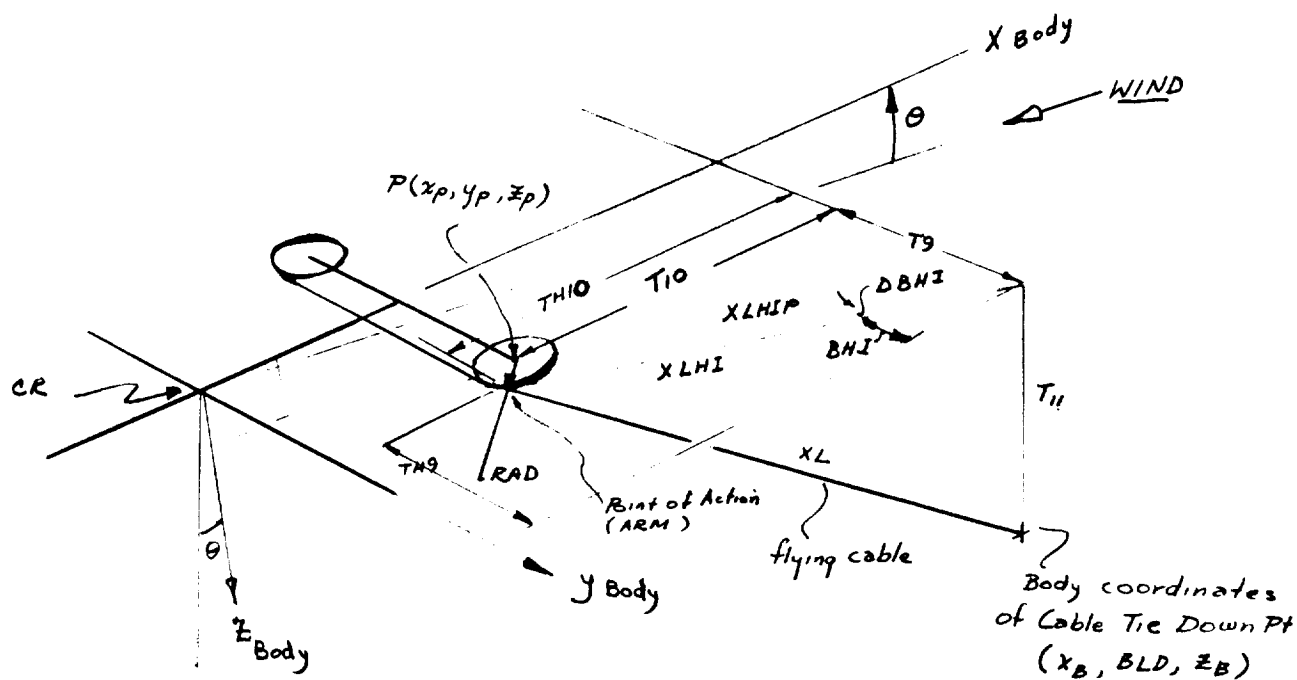


FIGURE 4.4 - FLOW CHART - SUBROUTINE FPLYV



x_p, y_p, z_p - body axis coordinates of pulley
 X_B, BLD, Z_B - body axis coordinate of cable attachment point
 XL - length of cable - inches
 $XLHI$ - projection of cable onto $X_{body} - Y_{body}$ plane
 RAD - pulley radius ~ inches

FIG. 4.5 - DEFINITION OF GEOMETRIC NOMENCLATURE

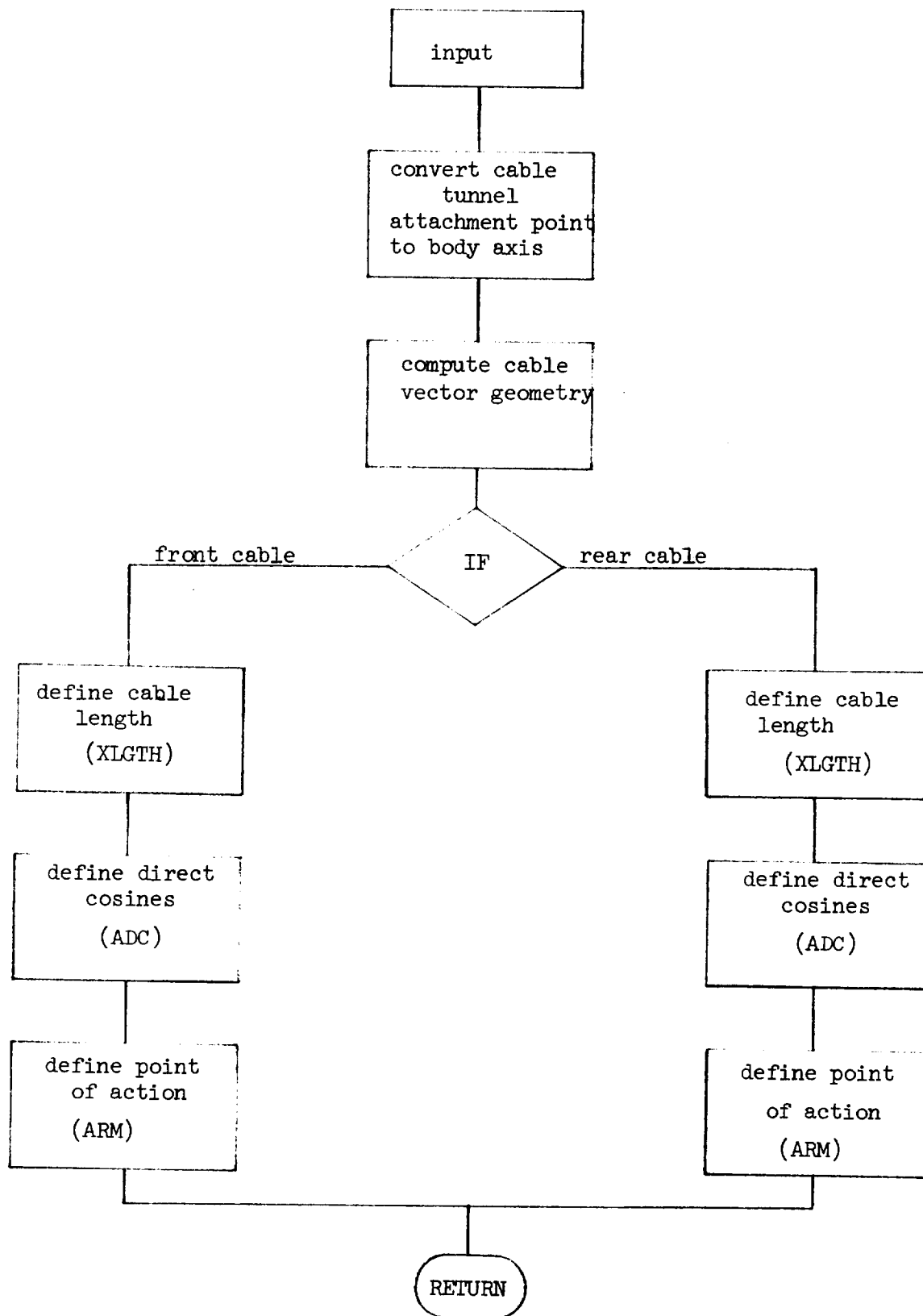


FIGURE 4.6 - FLOW CHART - SUBROUTINE RPLYH

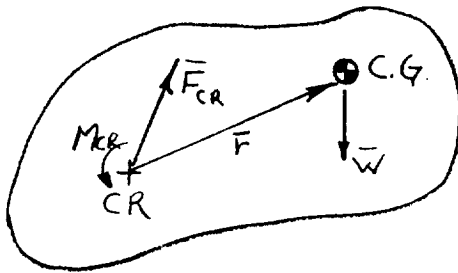
5.0 THEORETICAL DEVELOPMENT OF THE PERTURBED EQUATIONS OF MOTION FOR A CABLE SUSPENDED MODEL IN A WIND TUNNEL

The development is divided into four sub-sections. The first section presents a derivation of the linearized equations of motion. The following sections describe the derivation of the force and moment contributions due to the vehicle weight, aerodynamics and cable forces respectively.

5.1 DERIVATION OF LINEARIZED EQUATIONS OF MOTION

The linearized equation of motion is derived about the center of reference, "CR", rather than the center of gravity. The relative location is defined by the vector, \bar{r} , as shown in Figure 5.1.

\bar{F}_{CR} and \bar{M}_{CR} are the total force and moment less the weight contribution about point CR. Writing the equation of motion about the center of gravity:



$$\bar{F}_{CR} + m\bar{g} = m\bar{a}_{CG} \quad (5.1-1)$$

$$\bar{M}_{CR} - \bar{r} \times \bar{F}_{CR} = \frac{d}{dt} \bar{H} \quad (5.1-2)$$

Fig. 5.1

\bar{a} and \bar{H} are the translational acceleration and the angular momentum vector respectively.

The following relationships are noted for a rigid body

$$\text{Displacement:} \quad \bar{X}_{CG} = \bar{X}_{CR} + \bar{r} \quad (5.1-3)$$

$$\text{Rate:} \quad \bar{V}_{CG} = \bar{V}_{CR} + \bar{\omega} \times \bar{r} \quad (5.1-4)$$

$$\text{Acceleration:} \quad \bar{a}_{CG} = \bar{a}_{CR} + \dot{\bar{\omega}} \times \bar{r} + \bar{\omega} \times (\bar{\omega} \times \bar{r}) \quad (5.1-5)$$

$$\bar{\omega}_{CG} = \bar{\omega}_{CR}$$

where $\bar{\omega}$ is the rotation vector of the model.

Substituting equation 5.1- 5 into equation 5.1-1, we have:

$$\boxed{\bar{F}_{CR} + m (\bar{g} - \dot{\bar{\omega}} \times \bar{r}) - m \bar{\omega} \times (\bar{\omega} \times \bar{r}) = m \bar{a}_{CR}} \quad (5.1-6)$$

noting again that

$$\bar{H}_{CR} = \bar{H}_{CG} + m \bar{r} \times \frac{d\bar{r}}{dt} \quad (5.1-7)$$

or
$$\bar{H}_{CR} = \bar{H}_{CG} + m \bar{r} \times \cancel{\frac{d\bar{r}}{dt}} + \bar{\omega} \times \bar{r} \quad (5.1-8)$$

and
$$\frac{d\bar{H}_{CR}}{dt} = \frac{d\bar{H}_{CG}}{dt} + m \bar{r} \times (\dot{\bar{\omega}} \times \bar{r} + \bar{\omega} \times (\bar{\omega} \times \bar{r})) \quad (5.1-9)$$

Equations 5.1-6 and 5.1-9 can be solved for \bar{F}_{CR} and \bar{H}_{CG} respectively, and the results substituted into equation 5.1-2. Cancelling like items on both sides of the equation reduces 5.1-2 to:

$$\boxed{\bar{M}_{CR} - m \bar{r} \times (\bar{a}_{CR} - \bar{g}) = \frac{d\bar{H}_{CR}}{dt}} \quad (5.1-10)$$

Equations 5.1-6 and 5.1-10 represent the equation of motion about the point, "CR".

Equation 5.1-6 can further be simplified by noting that the initial rates and accelerations are zero because the vehicle is statically trimmed in the tunnel. The $\bar{\omega}$ must necessarily be a perturbation vector and $\bar{\omega} \times (\bar{\omega} \times \bar{r})$ represents a higher order term which will be ignored in the linearizing of the equation.

Equations 5.1-6 and 5.1-10 can now be written in the form:

$$\bar{F}_{CR} + m(\bar{g} - \dot{\bar{\omega}} \times \bar{r}) = m (\dot{\bar{V}} + \bar{\omega} \times \bar{V})_{CR} \quad (5.1-11)$$

$$\bar{M}_{CR} + m[\bar{r} \times (\bar{g} - \bar{a}_{CR})] = (\dot{\bar{H}} + \bar{\omega} \times \bar{H})_{CR} \quad (5.1-12)$$

These results show that to study perturbation motion about a point other than the center of gravity, the form of the pseudo linearized equation of motion is similar to that about the C.G. except for the gravity terms which are modified by $\dot{\bar{\omega}}$ and \bar{a}_{CR} .

Expanding the right hand side of equations 5.1-11 and 5.1-12 and assuming symmetry about the x-z plane, we have

$$\begin{aligned}
 \Sigma F_x &= m (\dot{U} - RV + QW) \\
 \Sigma F_y &= m (\dot{V} - PW + RU) \\
 \Sigma F_z &= m (\dot{W} - QU + PV) \\
 \Sigma L &= \dot{P} I_x - (\dot{R} + PQ) I_{xz} - QR (I_y - I_z) \\
 \Sigma M &= \dot{Q} I_y - (R^2 - P^2) I_{xz} - RP (I_z - I_x) \\
 \Sigma N &= \dot{R} I_z - (\dot{P} - QR) I_{xz} - PQ (I_x - I_y)
 \end{aligned} \tag{5.1-13}$$

The nomenclature in Eq 5.1-13 are used in the conventional manner. If each of the variables U,V,W, and P, Q, R are replaced by a steady state term plus an increment, e.g. $X = X_0 + \Delta X$: the expressions expanded and then noting that all the steady state terms are zero. 5.1-13 is simplified to

$$\begin{aligned}
 \Sigma F_x &= m \dot{u} \\
 \Sigma F_y &= m \dot{v} \\
 \Sigma F_z &= m \dot{w} \\
 \Sigma L &= \dot{p} I_x + \dot{r} I_{xz} \\
 \Sigma M &= \dot{q} I_y \\
 \Sigma N &= \dot{r} I_z - \dot{p} I_{xz}
 \end{aligned} \tag{5.1-14}$$

Returning to equation 5.1-11 and expanding the left hand side of the equation

$$\overline{F}_{CR} + \Delta \overline{F}_{CR} + m (\overline{g}_0 + \Delta \overline{g} - (\dot{\overline{\omega}}_0 + \dot{\overline{\omega}}) \times \overline{r}) = m \dot{\overline{v}} \tag{5.1-15}$$

we find that due to trim

$$\overline{F}_{CR} + \overline{mg}_0 = 0, \dot{\overline{\omega}}_0 = 0 \tag{5.1-16}$$

the perturbed force equation is thus:

$$\Delta \bar{F}_{CR} + m (\Delta \bar{g} - \bar{\omega} \times \bar{r}) = m \dot{\bar{v}} \quad (5.1-17)$$

$$\text{or} \quad \Delta \bar{F}_{CR} + \Delta \bar{W} = m \dot{\bar{v}} \quad (5.1-18)$$

The perturbed moment equation 5.1-12 can be similarly derived:

$$\bar{M}_{CR} + \Delta \bar{M}_{CR} + m \left[\bar{r} \times (\bar{g}_0 + \Delta \bar{g} + \bar{v}) \right] = \dot{\bar{H}} \quad (5.1-19)$$

$$\text{For trim} \quad \bar{M}_{CR} + m \bar{r} \times \bar{g}_0 = 0$$

$$\text{thus} \quad \Delta \bar{M}_{CR} + m [\bar{r} \times (\Delta \bar{g} - \bar{v})] = \dot{\bar{H}} \quad (5.1-20)$$

$$\text{or} \quad \Delta \bar{M}_{CR} + \Delta \bar{M}_{wgt} = \dot{\bar{H}} \quad (5.1-21)$$

Equation 5.1-18 and 5.1-21 can finally be written as

$$\Delta \bar{F}_{aero_{CR}} + \Delta \bar{F}_{cable_{CR}} + \Delta \bar{W} = m \dot{\bar{v}} \quad (5.1-22)$$

$$\Delta \bar{M}_{aero_{CR}} + \Delta \bar{M}_{cable_{CR}} + \Delta \bar{M}_{wgt} = \dot{\bar{H}} \quad (5.1-23)$$

The development of the weight, aerodynamic and cable terms are described in the following sections, 5.2, 5.3 and 5.4 respectively.

5.2 EXPANSION OF WEIGHT TERMS

The weight contribution about the point, CR, is defined by equations 5.1-18 and 5.1-21.

$$\Delta \bar{W} = m (\Delta \bar{g} - \bar{\omega} \times \bar{r}) \quad (5.2-1)$$

$$\Delta \bar{M}_{wgt} = m [\bar{r} \times (\Delta \bar{g} - \bar{v})]$$

The $\Delta \bar{g}$ term is derived from the trim weight vector which has the following components along the trim axis:

$$\begin{aligned} g_{x0_t} &= g \sin \theta_0 \\ g_{y0_t} &= g \cos \theta_0 \cos \phi. \\ g_{z0_t} &= g \cos \theta_0 \sin \phi. \end{aligned} \quad (5.2-2)$$

The Eulerian Transformation matrix 'E' for small perturbations is:

$$E = \begin{vmatrix} 1 & \Psi & -\theta \\ \Psi & 1 & \phi \\ \theta & -\phi & 1 \end{vmatrix} \quad (5.2-3)$$

The total contribution of \bar{g} along the instantaneous body axis is

$$\{ \bar{g}_B \} = E \{ g_t \} \quad (5.2-4)$$

Subtracting the steady state increment gives $\Delta \bar{g}_B$

$$\{ \Delta \bar{g}_B \} = E \{ g_t \} - \{ g_t \} = \begin{Bmatrix} -g \cos \theta_0 \theta \\ g [\sin \theta_0 \Psi + W \cos \theta_0 \phi] \\ g [-\sin \theta_0 \theta - \cos \theta_0 \phi] \end{Bmatrix} \quad (5.2-5)$$

The effective weight vector can now be determined if we note that:

$$\dot{\bar{\omega}} \times \bar{r} = \begin{vmatrix} \ddot{\phi} & \ddot{\theta} & \ddot{\Psi} \\ XCG & 0 & ZCG \end{vmatrix} = \begin{Bmatrix} ZCG \ddot{\theta} \\ XCG \ddot{\Psi} - ZCG \ddot{\phi} \\ -XCG \ddot{\theta} \end{Bmatrix} \quad (5.2-6)$$

$$\therefore \Delta \bar{W} = m \begin{Bmatrix} -g \cos \theta_0 \theta - ZCG \ddot{\theta} \\ g [\sin \theta_0 \Psi + W \cos \theta_0 \phi] - [XCG \ddot{\Psi} - ZCG \ddot{\phi}] \\ g [-\sin \theta_0 \theta - \cos \theta_0 \phi] + XCG \ddot{\theta} \end{Bmatrix} \quad (5.2-7)$$

The moment vector induced by the weight is determined

$$\Delta \bar{M}_{\text{wt}} = m \begin{vmatrix} XCG & 0 & ZCG \\ \Delta g_{bx} - x & \Delta g_{by} - y & \Delta g_{bz} - z \end{vmatrix} \quad (5.2-8)$$

$$\Delta \bar{M}_{WGT} = m \left\{ \begin{array}{l} -ZCG (\Delta g_{by} - \ddot{y}) \\ ZCG (\Delta g_{bx} - \ddot{x}) - XCG (\Delta g_{bz} - \ddot{z}) \\ XCG (\Delta g_{by} - \ddot{y}) \end{array} \right\} \quad (5.2-9)$$

where Δg_{bx} , Δg_{by} and Δg_{bz} are defined by equation 5.2-5

5.3 DERIVATION OF AERODYNAMIC CONTRIBUTION TO THE FORCES AND MOMENTS

The aerodynamic forces and moments of equation 5.1-22 and 5.1-23 can be expanded as equation 5.3-1.

$$\begin{aligned} \Delta F_{x_A} &= \frac{\partial F_{x_A}}{\partial \left(\frac{u}{V_o}\right)} \left(\frac{u}{V_o}\right) + \frac{\partial F_{x_A}}{\partial \left(\frac{\dot{\alpha c}}{2V_o^2}\right)} \left(\frac{\dot{\alpha c}}{2V_o^2}\right) + \frac{\partial F_{x_A}}{\partial \left(\frac{\dot{\theta c}}{2V_o}\right)} \left(\frac{\dot{\theta c}}{2V_o}\right) + \frac{\partial F_{x_A}}{\partial \delta_e} (\delta_e) \\ \Delta F_{y_A} &= \frac{\partial F_{y_A}}{\partial \left(\frac{v}{V_o}\right)} \left(\frac{v}{V_o}\right) + \frac{\partial F_{y_A}}{\partial \left(\frac{\dot{v}}{V_o}\right)} \left(\frac{\dot{v}}{V_o}\right) + \frac{\partial F_{y_A}}{\partial \left(\frac{pb}{2V_o}\right)} \left(\frac{pb}{2V_o}\right) + \frac{\partial F_{y_A}}{\partial \left(\frac{rb}{2V_o}\right)} \left(\frac{rb}{2V_o}\right) \\ &\quad + \frac{\partial F_{y_A}}{\partial \delta_R} (\delta_R) + \frac{\partial F_{y_A}}{\partial \delta_a} (\delta_a) \\ \Delta F_{z_A} &= \frac{\partial F_{z_A}}{\partial \left(\frac{w}{V_o}\right)} \left(\frac{w}{V_o}\right) + \frac{\partial F_{z_A}}{\partial \left(\frac{\dot{w}}{V_o}\right)} \left(\frac{\dot{w}}{V_o}\right) + \frac{\partial F_{z_A}}{\partial \left(\frac{\dot{\alpha c}}{2V_o^2}\right)} \left(\frac{\dot{\alpha c}}{2V_o^2}\right) + \frac{\partial F_{z_A}}{\partial \left(\frac{\dot{\theta c}}{2V_o}\right)} \left(\frac{\dot{\theta c}}{2V_o}\right) \\ &\quad + \frac{\partial F_{z_A}}{\partial \delta_e} (\delta_e) \\ \Delta L_A &= \frac{\partial L}{\partial \left(\frac{v}{V_o}\right)} \left(\frac{v}{V_o}\right) + \frac{\partial L}{\partial \left(\frac{\dot{v}}{V_o}\right)} \left(\frac{\dot{v}}{V_o}\right) + \frac{\partial L}{\partial \left(\frac{pb}{2V_o}\right)} \left(\frac{pb}{2V_o}\right) + \frac{\partial L}{\partial \left(\frac{rb}{2V_o}\right)} \left(\frac{rb}{2V_o}\right) \\ &\quad + \frac{\partial L}{\partial \delta_R} (\delta_R) + \frac{\partial L}{\partial \delta_a} (\delta_a) \end{aligned} \quad (5.3-1)$$

$$\begin{aligned}
\Delta M_A &= \frac{\partial M}{\partial \left(\frac{u}{V_o}\right)} \left(\frac{u}{V_o}\right) + \frac{\partial M}{\partial \left(\frac{w}{V_o}\right)} \left(\frac{w}{V_o}\right) + \frac{\partial M}{\partial \left(\frac{\dot{\alpha c}}{2V_o}\right)} \left(\frac{\dot{\alpha c}}{2V_o}\right) + \frac{\partial M}{\partial \left(\frac{\dot{\theta c}}{2V_o}\right)} \left(\frac{\dot{\theta c}}{2V_o}\right) \\
&+ \frac{\partial M}{\partial \delta_e} (\delta_e) \\
\Delta N_A &= \frac{\partial N}{\partial \left(\frac{v}{V_o}\right)} \left(\frac{v}{V_o}\right) + \frac{\partial N}{\partial \left(\frac{\dot{v}}{2V_o}\right)} \left(\frac{\dot{v}}{2V_o}\right) + \frac{\partial N}{\partial \left(\frac{pb}{2V_o}\right)} \left(\frac{pb}{2V_o}\right) + \frac{\partial N}{\partial \left(\frac{rb}{2V_o}\right)} \left(\frac{rb}{2V_o}\right) \\
&+ \frac{\partial N}{\partial \delta_r} (\delta_r) + \frac{\partial N}{\partial \delta_a} (\delta_a)
\end{aligned}$$

In the wind tunnel, the following relationship is true:

$$\begin{aligned}
\frac{w}{V_o} &= \theta + \frac{\dot{z}}{V_o}, \quad \frac{\dot{w}}{V_o} = \dot{\theta} + \frac{\ddot{z}}{V_o} \\
\frac{v}{V_o} &= -\psi + \frac{\dot{y}}{V_o}, \quad \frac{\dot{v}}{V_o} = -\dot{\psi} + \frac{\dot{y}}{V_o}
\end{aligned} \tag{5.3-2}$$

Substituting equations 5.3-2 and 5.1-4 into equation 5.3-2 and rewriting equation 5.3-2 in terms of the body axis coefficient we have:

$$\begin{aligned}
\Delta F_{X_A} &= \left[C_{x_w} \frac{qS}{V_o} \dot{x} + C_{x_\alpha} \frac{qS}{V_o} \dot{z} + C_{x_\alpha} \frac{qS\bar{c}}{2V_o} \ddot{z} + C_{x_\alpha} qS\theta \right. \\
&\quad \left. + \left(C_{x_\alpha} + C_{x_\theta} \right) \frac{qS\bar{c}}{2V_o} \dot{\theta} + C_{x_{\delta_e}} qS \delta_e \right]
\end{aligned} \tag{5.3-3.1}$$

$$\begin{aligned}
\Delta F_{Y_A} &= \left[C_{y_\beta} \frac{qS}{V_o} \dot{y} + C_{y_\beta} \frac{qS}{V_o} \ddot{y} + C_{y_p} \frac{qSb}{2V_o} \dot{\phi} + \left(-C_{y_\beta} + C_{y_r} \right) \frac{qSb}{2V_o} \dot{\psi} \right. \\
&\quad \left. - C_{y_\beta} qS\psi + C_{y_{\delta_r}} qS\delta_r + C_{y_{\delta_a}} qS\delta_a \right]
\end{aligned} \tag{5.3-3.2}$$

$$\begin{aligned}
\Delta F_{Z_A} &= \left[C_{z_u} \frac{qS}{V_o} \dot{x} + C_{z_\alpha} \frac{qS}{V_o} \dot{z} + C_{z_\alpha} \frac{qS\bar{c}}{2V_o} \ddot{z} + C_{z_\alpha} qS\theta + \left(C_{z_\alpha} + C_{z_\theta} \right) \frac{qS\bar{c}}{2V_o} \dot{\theta} \right. \\
&\quad \left. + C_{z_{\delta_e}} qS \delta_e \right]
\end{aligned} \tag{5.3-3.3}$$

$$\Delta L_A = \left[C_{\ell_\beta} \frac{qSb}{V_0} \dot{y} + C_{\ell_\beta} \frac{qSb}{V_0} \ddot{y} + C_{\ell_p} \frac{qSb^2}{2V_0} \dot{\phi} + \left(C_{\ell_r} - C_{\ell_\beta} \right) \frac{qSb^2}{2V_0} \ddot{\phi} \right. \\ \left. - C_{\ell_\beta} qSb\psi + C_{\ell_{\delta_r}} qSb\delta_r + C_{\ell_{\delta_a}} qSb\delta_a \right] \quad (5.3-3.4)$$

$$\Delta M_A = \left[C_{m_u} \frac{qSc}{V_0} \dot{x} + C_{m_\alpha} \frac{qSc}{V_0} \dot{z} + C_{m_\alpha} \frac{qSc^2}{2V_0} \ddot{z} + C_{m_\alpha} qSc\theta \right. \\ \left. + \left(C_{m_\alpha} + C_{m_\theta} \right) \frac{qSc^2}{2V_0} \ddot{\theta} + C_{m_{\delta_e}} qSc\delta_e \right] \quad (5.3-3.5)$$

$$\Delta N_A = \left[C_{n_\beta} \frac{qSb}{V_0} \dot{y} + C_{n_\beta} \frac{qSb}{V_0} \ddot{y} + C_{n_p} \frac{qSb^2}{2V_0} \dot{\phi} + \left(C_{n_r} - C_{n_\beta} \right) \frac{qSb^2}{2V_0} \ddot{\phi} \right. \\ \left. - C_{n_\beta} qSb\psi + C_{n_{\delta_r}} qSb\delta_r + C_{n_{\delta_a}} qSb\delta_a \right] \quad (5.3-3.6)$$

5.4 DERIVATION OF THE CABLE FORCES AND MOMENTS

The generalized force and moment equations for a single cable are defined. The forces and moments of the entire cable system are then obtained by the proper summation of each individual cable contribution.

For a single cable, a component of force along any trim axis can be written in terms of the tension in the cable and its direction cosine with respect to the axis. i.e.

$$F_i = T \cos \alpha_i \quad i = x, y \text{ or } z \quad (5.4-1)$$

The instantaneous force component, due to changes in the cable tension and direction cosine, along the trim axis can be defined as:

$$(F_0 + \Delta F)_i = (T + \Delta T) \cos (\alpha + \Delta\alpha)_i \quad (5.4-2)$$

where F_O is the steady state force component and ΔF the change in this component. Expanding this expression and linearizing, we have:

$$F_{I_i} = (F_O + \Delta F)_i = T \cos \alpha_i + \Delta T \cos \alpha_i - T \Delta \alpha_i \sin \alpha_i \quad (5.4-3.1)$$

$$\text{or} \quad F_{O_i} = T \cos \alpha_i \quad (5.4-3.2)$$

$$\Delta F_i = \Delta T \cos \alpha_i - T \Delta \alpha_i \sin \alpha_i \quad (5.4-3.3)$$

The force, in equation 5.4-2, is the instantaneous force along the trim body axis. The instantaneous body axis may be displaced through perturbation angles Ψ , θ and ϕ . To obtain the force along the instantaneous body axis, vector F_I , is transformed via the Eulerian transformation matrix defined in equation 5.2-2.

$$\left\{ F_I \right\}_B = \left\{ F_O + \Delta F \right\}_B = E \left\{ F_O + \Delta F \right\}_T \quad (5.4-4)$$

Expanded, equation 5.4-4 takes the following form:

$$\begin{aligned} \left\{ F_I \right\}_B &= \begin{bmatrix} 1 & \Psi & -\theta \\ -\Psi & 1 & \phi \\ \theta & -\phi & 1 \end{bmatrix} \left\{ F_O + \Delta F \right\}_T \\ &= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \left\{ F_O \right\}_T + \begin{bmatrix} 0 & \Psi & -\theta \\ -\Psi & 0 & \phi \\ \theta & -\phi & 0 \end{bmatrix} \left\{ F_O \right\}_T \\ &+ \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \left\{ \Delta F \right\}_T + \text{HOT} \end{aligned} \quad (5.4-5)$$

The first term is the steady state term, the next term is due to rotation of the body axis and the third is due to the perturbation of the steady state force. Subtracting the steady state force, the incremental change in the cable force projected on the instantaneous body axis is obtained.

$$\left\{ \Delta F_I \right\}_B = \left\{ \begin{bmatrix} \Delta F_{T_1} + \Psi F_{To_2} - \theta F_{To_3} \\ \Delta F_{T_2} - \Psi F_{To_1} + \phi F_{To_3} \\ \Delta F_{T_3} + \theta F_{To_1} - \phi F_{To_2} \end{bmatrix} \right\} \quad (5.4-6)$$

To determine the incremental change in moment about the instantaneous body axis, the vector notation of the generalized moment vector, \bar{K} , is written as:

$$\bar{K} = \left(\bar{x}_p \times \bar{F}_I \right)_B \quad (5.4-7)$$

\bar{x}_p is the vector from the center of rotation to the point of action of the cable force, \bar{F}_I . This vector has been defined in the trim analysis. \bar{F}_I is defined by the matrix in equation 5.4-5.

Expanding the equation and subtracting the steady state moment term out, the following is obtained:

$$\left\{ \Delta K \right\} = \begin{bmatrix} \Delta L \\ \Delta M \\ \Delta N \end{bmatrix}_B = \left\{ \begin{bmatrix} y_p \Delta F_{T_3} - z_p \Delta F_{T_2} + z_p F_{To_1} \Psi - \left(y_p F_{To_2} + z_p F_{To_3} \right) \phi \\ z_p \Delta F_{T_1} - x_p \Delta F_{T_3} - \left(z_p F_{To_3} + x_p F_{To_1} \right) \theta \\ x_p \Delta F_{T_2} - y_p \Delta F_{T_1} - \left(x_p F_{To_1} + y_p F_{To_2} \right) \Psi + x_p F_{To_3} \phi \end{bmatrix} \right\} \quad (5.4-8)$$

Equations 5.4-6 and 5.4-8 are the generalized cable forces and moments for a single cable. The force terms with a subscript zero are defined by equation 5.4-3.2. The ΔF_i increments are obtained from equation 5.4-3.3 once ΔT and $\Delta \alpha_i$ are defined. The change in tension force, ΔT , is proportional to Δl via the spring constant. The $\Delta \alpha_i$ is the change in the direction cosine with respect to the trim axis.

To determine ΔT and $\Delta \alpha_i$ the vector representation of the cable at any instant of time must be defined with respect to the trim axis.

Let \bar{X}_{WT} represent the vector to the cable tie-down point the tunnel wall from the center of reference in the trim axis systems and \bar{X}_{p_B} the vector to the point of action in the body axis. Let \bar{X}_{p_T} be the transformation of \bar{X}_{p_B} onto the trim axis system. i.e.

$$\bar{X}_{p_T} = \left\{ \begin{matrix} X_p \\ Y_p \\ Z_p \end{matrix} \right\}_T = E^{-1} \left\{ \begin{matrix} X_p \\ Y_p \\ Z_p \end{matrix} \right\}_B \quad (5.4-9)$$

The cable vector is thus defined by equation 5.4-10

$$\bar{A} = \bar{X}_{WT} - \bar{X}_{p_T} = \left\{ \ell \cos \alpha_i + \delta_i \right\}_{i=1, 2, 3} \quad (5.4-10)$$

where δ_i is defined by the following:

$$\begin{aligned} \delta_1 &= -(-y_p \Psi + z_p \Theta + x) \\ \delta_2 &= -(x_p \Psi - z_p \Phi + y) \\ \delta_3 &= -(-x_p \Theta + y_p \Phi + z) \end{aligned} \quad (5.4-11)$$

$x, y, z, \Psi, \Theta, \Phi$ are perturbation variables.

The magnitude of \bar{A} is the instantaneous length of the cable. Expanding and linearizing the equation gives the following:

$$\ell_o + \Delta \ell = |\bar{A}| = \ell_o + \sum_{i=1}^3 \cos \alpha_i \delta_i \quad (5.4-12)$$

or

$$\boxed{\Delta \ell = \sum \cos \alpha_i \delta_i} \quad (5.4-13)$$

The incremental change in direction cosine can be determined by defining the unit vector along \bar{A} and then taking the dot product along the x, y, z axis.

$$\cos (\alpha + \Delta \alpha)_i = \left(\frac{\bar{A}}{\ell + \Delta \ell} \right) \cdot \bar{u}_i \quad (5.4-14)$$

where \bar{u}_i is the unit vector along the i^{th} trim axis

Expanding and linearizing:

$$\begin{aligned} \ell \cos \alpha_i + \Delta \ell \cos \alpha_i - \Delta \alpha_i \ell \sin \alpha_i &= \bar{A} \cdot \bar{u}_i \\ &= (\bar{X}_{wt} - \bar{X}_{pt}) \cdot \bar{u}_i \end{aligned} \quad (5.4-15)$$

$$\text{or } \Delta \alpha_i = \frac{1}{\ell \sin \alpha_i} \left[\ell \cos \alpha_i + \Delta \ell \cos \alpha_i - (\bar{X}_{wT} - \bar{X}_p) \cdot \bar{u}_i \right] \quad (5.4-16)$$

Since from equation 5.4-10 :

$$(\bar{X}_{wT} - \bar{X}_{pT}) \cdot \bar{u}_i = (\ell \cos \alpha_i + \delta_i) \quad (5.4-17)$$

Equation 5.4-16 simplifies to:

$$\boxed{\Delta \alpha_i = \frac{1}{\ell \sin \alpha_i} \left[\Delta \ell \cos \alpha_i - \delta_i \right]} \quad (5.4-18)$$

Equations 5.4-13 and 5.4-18 are the necessary equations to define ΔF in equations 5.4-6 and 5.4-8. In Sections 6.0 and 7.0, these equations are simplified for the longitudinal and lateral directional analysis to obtain the influence coefficient matrix.

6.0 Longitudinal Stability Analysis

6.1 Subroutine LONG

This subroutine computes the perturbed forces and moments for the longitudinal perturbation equations of motion and extracts the characteristic roots for a stability analysis.

The general form of the linearized equation of motion (5.1-14) is reduced to equation 6.1-1 for the longitudinal analysis.

$$\begin{aligned}\Sigma \Delta F_x &= m\dot{u} = m\ddot{x} \\ \Sigma \Delta F_z &= m\dot{w} = m\ddot{z} \\ \Sigma \Delta M_y &= I_y \dot{q} = I_y \ddot{\theta}\end{aligned}\tag{6.1-1}$$

x , z and θ are the longitudinal perturbation variables. $\Sigma \Delta F_x$, $\Sigma \Delta F_z$ and $\Sigma \Delta M$ are further expanded in equation 6.1-2.

$$\begin{aligned}\Sigma \Delta F_x &= \Delta F_{x_{aero}} + \Delta F_{x_{wt}} + \Delta F_{x_{cable}} + \Delta F_{x_{snubber}} \\ \Sigma \Delta F_z &= \Delta F_{z_{aero}} + \Delta F_{z_{wt}} + \Delta F_{z_{cable}} + \Delta F_{z_{snubber}} \\ \Sigma \Delta M_y &= \Delta M_{aero} + \Delta M_{wt} + \Delta M_{cable} + \Delta M_{snubber}\end{aligned}\tag{6.1-2}$$

The aerodynamic forces and moments, $\Delta F_{x_{aero}}$, $\Delta F_{z_{aero}}$ and ΔM_{aero} , are defined by equations 5.3-3.1, 5.3-3.3 and 5.3-3.5 respectively. The weight contributions are defined by equations 5.2-7 and 5.2-9 and simplify to equation 6.1-3 with y , Ψ , $\phi = 0$.

$$\begin{aligned}\Delta F_{x_{wt}} &= W \cos \theta_o \theta - Z_{CG} M \ddot{\theta} \\ \Delta F_{z_{wt}} &= W \sin \theta_o \theta = x_{CG} M \ddot{\theta} \\ \Delta M_{wt} &= z_{CG} (W \cos \theta_o \theta + m\ddot{x}) + x_{CG} (W \sin \theta_o \theta + m\ddot{z})\end{aligned}\tag{6.1-3}$$

The cable forces and moment are obtained from generalized equations 5.4-6 and 5.4-8 respectively.

$$\begin{aligned}\Delta F_1 &= \Delta F_x = \Delta F_{T_1} - \theta F_{T_{O_3}} \\ \Delta F_3 &= \Delta F_z = \Delta F_{T_3} + \theta F_{T_{O_1}} \\ \Delta M_y &= z_p \Delta F_{T_1} - x_p \Delta F_{T_3} - (z_p F_{T_{O_3}} + x_p F_{T_{O_1}}) \theta\end{aligned}\tag{6.1-4}$$

where according to equations 5.4-3.2 and 5.4-3.3

$$\begin{aligned}F_{T_{O_i}} &= T_i \cos \alpha_i \quad i = 1, 3 \\ \text{and} \\ \Delta F_{T_i} &= \Delta T_i \cos \alpha_i - T \Delta \alpha_i \sin \alpha_i\end{aligned}\tag{6.1-5}$$

The steady state direction cosine angle, α_i and cable tension, T_i are obtained from the trim analysis. The ΔT_i and $\Delta \alpha_i$ are proportional to the longitudinal perturbation variables. The ΔT_i for the rear cable is defined by equation 6.1-6 .

$$\Delta T_R = AKR (\Delta \ell_3 + \Delta \ell_4)\tag{6.1-6}$$

The ΔT_F for the front cable is a variable in the analysis. The constant front cable length requirement is a constraint equation which in conjunction with the equations of motion defines a unique solution of the variables x , z , θ and ΔT_F .

The constraint equation is:

$$\Delta \ell_1 + \Delta \ell_2 = 0\tag{6.1-7}$$

Since:

$$\Delta \ell_1 = \frac{\partial \Delta \ell_1}{\partial x} x + \frac{\partial \Delta \ell_1}{\partial z} z + \frac{\partial \Delta \ell_1}{\partial \theta} \theta\tag{6.1-8}$$

$$\Delta \ell_2 = \frac{\partial \Delta \ell_2}{\partial x} x + \frac{\partial \Delta \ell_2}{\partial z} z + \frac{\partial \Delta \ell_2}{\partial \theta} \theta\tag{6.1-9}$$

The following relation of $x = f(z, \theta)$ is determined.

$$x = \frac{\left[\left(\frac{\partial \Delta \ell_1}{\partial z} + \frac{\partial \Delta \ell_2}{\partial z} \right) z + \left(\frac{\partial \Delta \ell_1}{\partial \theta} + \frac{\partial \Delta \ell_2}{\partial \theta} \right) \theta \right]}{\left(\frac{\partial \Delta \ell_1}{\partial x} + \frac{\partial \Delta \ell_2}{\partial x} \right)} \quad (6.1-10)$$

The coefficients for $\Delta \ell_i$ are defined by subroutine DLGTH described in Section 6.3. Similarly the coefficient of $\Delta \alpha_i$ are defined in subroutine DCOSLG.

The cable forces and moment equations are reduced to functions of the basic variables x, z, θ and ΔT_F via the subroutine MASH for each individual cable. The results are then summed in the FXS array which in its final form, becomes the cable influence coefficient matrix. The initial form of the cable matrix for the front and rear flying cable are presented in Figures 6.1 and 6.2 respectively.

The stability characteristic matrix and the expanded form of the equations of motion are presented in Figure 6.3. A functional flow diagram of subroutine LONG is included as Figure 6.4.

6.2 Subroutine DLGTH

This subroutine computes the change in length of a cable for either the longitudinal or the lateral/directional perturbation stability analysis. An index, IDX, determines the mode that is being analyzed, and the correct form of $\Delta \ell$ is computed.

The variation of the cable length with respect to the longitudinal variables is defined by the partial derivatives in equation 6.2-1.

$$\Delta \ell = \frac{\partial \Delta \ell}{\partial x} x + \frac{\partial \Delta \ell}{\partial z} z + \frac{\partial \Delta \ell}{\partial \theta} \theta \quad (6.2-1)$$

These "partials" are determined from the generalized form for $\Delta \ell$ in equations 5.4-13 and 5.4-11. Equating the lateral/directional perturbation variables, y, ϕ and ψ to zero, the equation for $\Delta \ell$ is reduced to the following simplified form.

$$\Delta \ell = - \cos \alpha_1 x - \cos \alpha_3 z + \left(x_p \cos \alpha_3 - z_p \cos \alpha_1 \right) \theta \quad (6.2-2)$$

The subscripts 1 and 3 refer to the x and z body axis respectively. x_p and z_p corresponds to the coordinates of the cable force point of action. In the program, an added subscript, IC, is used

to define the particular cable being analyzed.

In the lateral directional mode, the coefficient of the y , Ψ , and ϕ variables in the lateral directional form of Δl is computed.

$$\Delta l = \frac{\partial \Delta l}{\partial y} y + \frac{\partial \Delta l}{\partial \Psi} \Psi + \frac{\partial \Delta l}{\partial \phi} \phi \quad (6.2-3)$$

The coefficients are again obtained from equations 5.4-13 and 5.4-11, but now x , z , and θ is assumed zero. The expression for Δl is reduced to equation 6.2-4.

$$\begin{aligned} \Delta l = & - \cos \alpha_2 y + [y_p \cos \alpha_1 - x_p \cos \alpha_2] \Psi + [z_p \cos \alpha_2 \\ & - y_p \cos \alpha_3] \phi \end{aligned} \quad (6.2-4)$$

The subscript 2 refers to the y body axis.

The expressions in equations 6.2-2 and 6.2-4 can be shown to be algebraically equivalent to their corresponding expressions in Reference 1. A functional flow diagram is included in Figure 6.3.

6.3 Subroutine DCOSLG

This subroutine computes the components of the $\Delta \alpha_1$ and $\Delta \alpha_3$ vectors required by subroutine LONG. Due to the symmetry of the longitudinal analysis, $\Delta \alpha_2$ is not required. The expressions for both $\Delta \alpha_1$ and $\Delta \alpha_3$ are obtained from equation 5.4-18. Expanding this expression and letting y , Ψ , and ϕ equal zero, the expressions for $\Delta \alpha_1$ and $\Delta \alpha_3$ are developed.

$$\begin{aligned} \Delta \alpha_1 = & \left(\frac{\sin \alpha_1}{\ell} \right) x + \left(\frac{\cos \alpha_3 \cot \alpha_1}{\ell} \right) z \\ & + \left(\frac{z_p \sin \alpha_1 + x_p \cos \alpha_3}{\ell} \right) \theta \\ \Delta \alpha_3 = & - \left(\frac{\cos \alpha_1 \cot \alpha_3}{\ell} \right) x + \left(\frac{\sin \alpha_3}{\ell} \right) z \\ & - \left(\frac{z_p \cos \alpha_1 \cot \alpha_3 + x_p \sin \alpha_3}{\ell} \right) \theta \end{aligned}$$

The subscripts 1 or 3 again refer to the x and z axis respectively. The x_p and z_p are the x and z components of the vector from the center of reference to the point of action of the cable force.

LONGITUDINAL FROM CABLE MATRIX

β	θ	ΔT_F	x	$\Delta \alpha_i$	$\Delta \alpha_3$
	$-T \cos \alpha_3$	$\cos \alpha_i$		$-T \sin \alpha_i$	
	$T \cos \alpha_i$	$\cos \alpha_3$			$-T \sin \alpha_3$
	$-\beta_p T \cos \alpha_3 - x_p T \cos \alpha_i$	$\beta_p \cos \alpha_i - x_p \cos \alpha_3$		$-\beta_p T \sin \alpha_i$	$x_p T \sin \alpha_3$
$\frac{\partial x}{\partial \beta}$	$\frac{\partial x}{\partial \theta}$		-1		
$\Delta \alpha_{1\beta}$	$\Delta \alpha_{1\theta}$		$\Delta \alpha_{1x}$	-1	
$\Delta \alpha_{3\beta}$	$\Delta \alpha_{3\theta}$		$\Delta \alpha_{3x}$		-1

Equation:

- $\Delta F_{xc} = \Delta F_{T1} - \theta F_{T03} = (\cos \alpha_i \Delta T_F - T_{F0} \sin \alpha_i \Delta \alpha_i) - T_{F0} \cos \alpha_3 \theta$ (eq 6.1-4)
- $\Delta F_{2c} = \Delta F_{T3} + \theta F_{T01} = (\cos \alpha_3 \Delta T_F - T_{F0} \sin \alpha_3 \Delta \alpha_3) + T_{F0} \cos \alpha_i \theta$ (eq 6.1-4)
- $\Delta M_c = \beta_p \Delta F_{T1} - x_p \Delta F_{T3} - (\beta_p F_{T03} + x_p F_{T01}) \theta$ (eq 6.1-4)
- $x = \frac{\partial x}{\partial \beta} \beta + \frac{\partial x}{\partial \theta} \theta$ (eq 6.1-10)
- $\Delta \alpha_i = \Delta \alpha_{i\beta} \beta + \Delta \alpha_{i\theta} \theta + \Delta \alpha_{ix} x$ (eq 6.3-1)
- $\Delta \alpha_3 = \Delta \alpha_{3\beta} \beta + \Delta \alpha_{3\theta} \theta + \Delta \alpha_{3x} x$ (eq 6.3-2)

FIG. 6.1 - MATRIX

LONGITUDINAL REAR CLLE MATRIX

j	θ	x	ΔT_R	$\Delta \alpha_1$	$\Delta \alpha_3$	$\Delta l_3 + \Delta l_4$
①	$-T_{R0} \cos \alpha_3$		$\cos \alpha_1$	$-T_{R0} \sin \alpha_1$		
②	$T_{R0} \cos \alpha_1$		$\cos \alpha_3$		$-T_{R0} \sin \alpha_3$	
③	$-\sum_p T_{R0} \cos \alpha_3 - \sum_p T_{R0} \cos \alpha_1$		$\sum_p \cos \alpha_1 - \sum_p \cos \alpha_3$	$-\sum_p T_{R0} \sin \alpha_1$	$\sum_p T_{R0} \sin \alpha_3$	
④			-1			AKR
⑤	$\Delta \alpha_{1T}$	$\Delta \alpha_{1x}$		-1		
⑥	$\Delta \alpha_{3T}$	$\Delta \alpha_{1x}$			-1	
⑦	$\Delta l_{30} + \Delta l_{40}$	$\Delta l_{3x} + \Delta l_{4x}$				-1

- Equations
- ① $\Delta F_{x_c} = \Delta F_{T_1} - \theta F_{T_0} = (\cos \alpha_1 \Delta T_R - T_{R0} \sin \alpha_1 \Delta \alpha_1) - T_{R0} \cos \alpha_3 \theta$ (eq. 6.1-4)
 - ② $\Delta F_{z_c} = \Delta F_{T_3} + \theta F_{T_0} = (\cos \alpha_3 \Delta T_R - T_{R0} \sin \alpha_3 \Delta \alpha_3) + T_{R0} \cos \alpha_1 \theta$ (eq. 6.1-4)
 - ③ $\Delta M_c = \sum_p \Delta F_{T_1} - \sum_p \Delta F_{T_3} - (\sum_p F_{T_0} + \sum_p F_{T_0}) \theta$ (eq. 6.1-4)
 - ④ $\Delta T_R = AKR (\Delta l_3 + \Delta l_4)$ (eq. 6.1-6)
 - ⑤ $\Delta \alpha_1 = \Delta \alpha_{1z} + \Delta \alpha_{10} \theta + \Delta \alpha_{1x} x$ (eq. 6.3-1)
 - ⑥ $\Delta \alpha_3 = \Delta \alpha_{3z} + \Delta \alpha_{30} \theta + \Delta \alpha_{3x} x$ (eq. 6.3-2)
 - ⑦ $\Delta l_3 + \Delta l_4 = (\Delta l_{3z} + \Delta l_{4z}) + (\Delta l_{30} + \Delta l_{40}) \theta + (\Delta l_{3x} + \Delta l_{4x}) x$ (eq. 6.2-1)

FIG. 6.2 - MATRIX

LONGITUDINAL CHARACTERISTIC MATRIX & EQUATIONS

β	θ	ΔT_F	x
$- \left[\left(\frac{\partial X_A}{\partial \alpha} \right) A^2 + \left(\frac{\partial X_A}{\partial \alpha} + \frac{\partial X_{SN}}{\partial \beta} \right) A + \frac{\partial X_C}{\partial \beta} \right]$	$m Z_{CG} A^2 - \left(\frac{\partial X_A}{\partial \theta} + \frac{\partial X_A}{\partial \alpha} + \frac{\partial X_{SN}}{\partial \theta} \right) A + W \cos \theta_0 - \left(\frac{\partial X_C}{\partial \theta} + \frac{\partial X_A}{\partial \alpha} \right) V_0$	$- \frac{\partial X_C}{\partial \Delta T_F}$	$m A^2 - \left(\frac{\partial X_A}{\partial \alpha} + \frac{\partial X_{SN}}{\partial \beta} \right) A - \frac{\partial X_C}{\partial \beta}$
$\left(m - \frac{Z_A}{V_0} \right) A^2 - \left(\frac{\partial Z_A}{\partial \alpha} + \frac{\partial Z_{SN}}{\partial \beta} \right) A - \frac{\partial Z_C}{\partial \beta}$	$-m X_{CG} A^2 - \left(\frac{\partial Z_A}{\partial \theta} + \frac{\partial Z_A}{\partial \alpha} + \frac{\partial Z_{SN}}{\partial \theta} \right) A + W \sin \theta_0 - \left(\frac{\partial Z_C}{\partial \theta} + \frac{\partial Z_A}{\partial \alpha} \right) V_0$	$- \frac{\partial Z_C}{\partial \Delta T_F}$	$- \left(\frac{\partial Z_A}{\partial \alpha} + \frac{\partial Z_{SN}}{\partial \beta} \right) A - \frac{\partial Z_C}{\partial \beta}$
$- \left(\frac{\partial M_Y}{\partial \alpha} X_A + m X_{CG} \right) A^2 - \left(\frac{\partial M_Y}{\partial \alpha} X_A + \frac{\partial M_{Y_{SN}}}{\partial \beta} \right) A - \frac{\partial M_{Y_C}}{\partial \beta}$	$I_{YY} A^2 - \left(\frac{\partial M_Y}{\partial \theta} X_A + \frac{\partial M_Y}{\partial \alpha} X_A + \frac{\partial M_{Y_{SN}}}{\partial \theta} \right) A - \left(\frac{\partial M_{Y_C}}{\partial \theta} + \frac{\partial M_{Y_C}}{\partial \alpha} + \frac{\partial M_{Y_{SN}}}{\partial \theta} \right) X_{CG} W \sin \theta_0$	$- \frac{\partial M_{Y_C}}{\partial \Delta T_F}$	$m Z_{CG} A^2 - \left(\frac{\partial M_Y}{\partial \alpha} X_A + \frac{\partial M_{Y_{SN}}}{\partial \beta} \right) A - \frac{\partial M_{Y_C}}{\partial \beta}$
$- \frac{\partial x}{\partial \beta}$	$- \frac{\partial x}{\partial \theta}$		1

X-Force Equation:

$$m \ddot{x} = \underbrace{\frac{\partial X_A}{\partial \alpha} \dot{x} + \frac{\partial X_A}{\partial \alpha} \dot{\alpha} + \frac{\partial X_A}{\partial \beta} \dot{\beta}}_{\text{Aero}} - \underbrace{W \cos \theta_0 \theta - m Z_{CG} \ddot{\theta}}_{\text{Weight}} + \underbrace{\frac{\partial X_C}{\partial \alpha} \dot{x} + \frac{\partial X_C}{\partial \beta} \dot{\beta} + \frac{\partial X_C}{\partial \theta} \dot{\theta} + \frac{\partial X_C}{\partial \Delta T_F} \dot{\Delta T_F}}_{\text{Cable Spring Force}} + \underbrace{\frac{\partial X_{SN}}{\partial \beta} \dot{\beta} + \frac{\partial X_{SN}}{\partial \theta} \dot{\theta}}_{\text{Snubbed Damping Force}}$$

Z-Force Equation:

$$m \ddot{z} = \underbrace{\frac{\partial Z_A}{\partial \alpha} \dot{x} + \frac{\partial Z_A}{\partial \alpha} \dot{\alpha} + \frac{\partial Z_A}{\partial \beta} \dot{\beta}}_{\text{Aero}} - \underbrace{W \sin \theta_0 \theta - m X_{CG} \ddot{\theta}}_{\text{Weight}} + \underbrace{\frac{\partial Z_C}{\partial \alpha} \dot{x} + \frac{\partial Z_C}{\partial \beta} \dot{\beta} + \frac{\partial Z_C}{\partial \theta} \dot{\theta} + \frac{\partial Z_C}{\partial \Delta T_F} \dot{\Delta T_F}}_{\text{Cable Spring Force}} + \underbrace{\frac{\partial Z_{SN}}{\partial \beta} \dot{\beta} + \frac{\partial Z_{SN}}{\partial \theta} \dot{\theta}}_{\text{Snubbed Damping Force}}$$

Pitching Moment Equation:

$$I_{YY} \ddot{\theta} = \underbrace{\frac{\partial M_Y}{\partial \alpha} \dot{x} + \frac{\partial M_Y}{\partial \alpha} \dot{\alpha} + \frac{\partial M_Y}{\partial \beta} \dot{\beta}}_{\text{Aero Moment}} + \underbrace{Z_{CG} W \cos \theta_0 + X_{CG} W \sin \theta_0 \theta - Z_{CG} m \ddot{x} + X_{CG} m \ddot{z}}_{\text{Weight Element}} + \underbrace{\frac{\partial M_{Y_C}}{\partial \alpha} \dot{x} + \frac{\partial M_{Y_C}}{\partial \beta} \dot{\beta} + \frac{\partial M_{Y_C}}{\partial \theta} \dot{\theta} + \frac{\partial M_{Y_C}}{\partial \Delta T_F} \dot{\Delta T_F}}_{\text{Cable Spring Moment}} + \underbrace{\frac{\partial M_{Y_{SN}}}{\partial \beta} \dot{\beta} + \frac{\partial M_{Y_{SN}}}{\partial \theta} \dot{\theta}}_{\text{Snubbed Damping Moment}}$$

Constraint Equation:

$$x = - \frac{\partial x}{\partial \beta} \beta - \frac{\partial x}{\partial \theta} \theta$$

Auxiliary Equations:

$$\dot{x} = \dot{\alpha} + \dot{\beta}$$

FIG. 6.3 - MATRIX

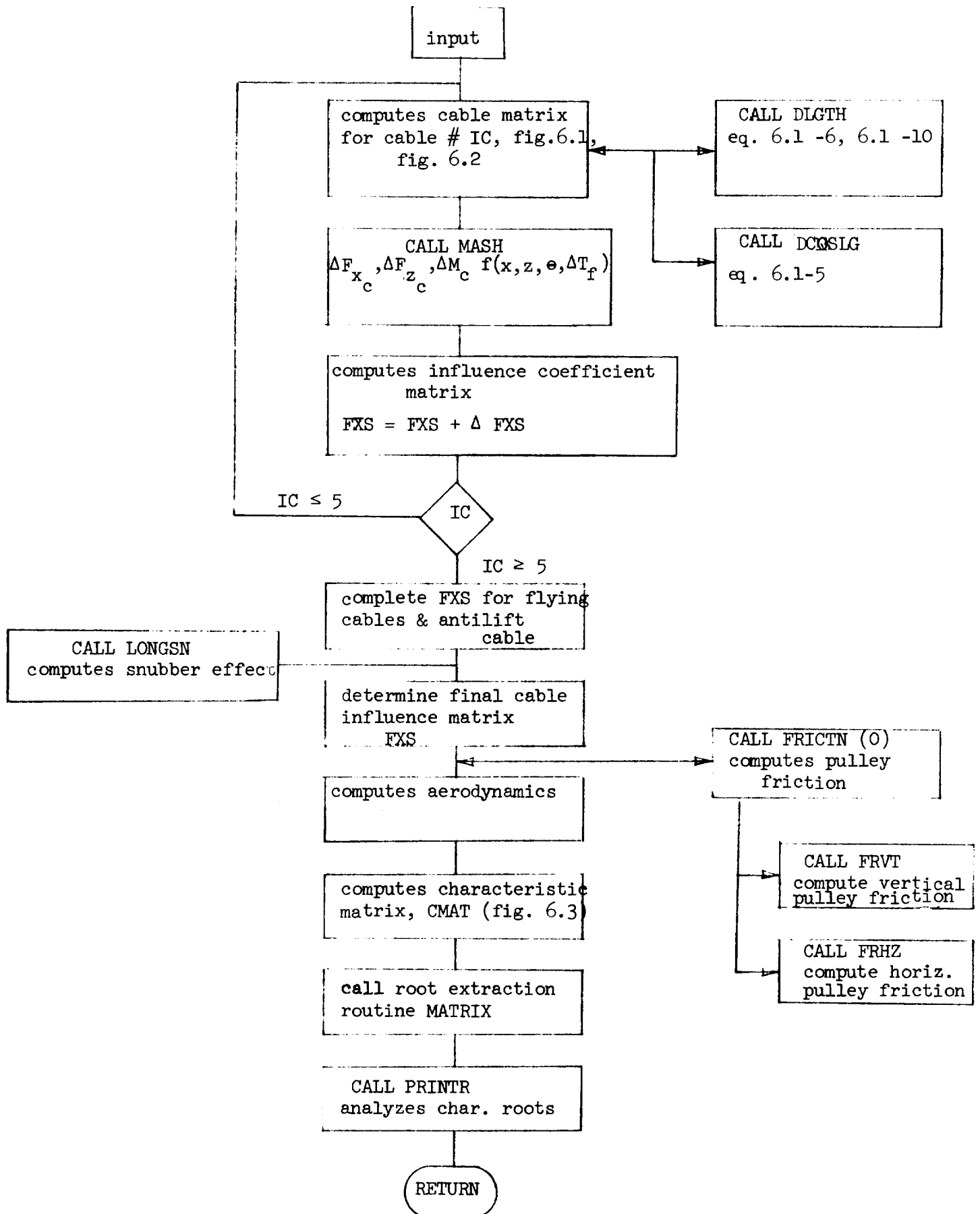
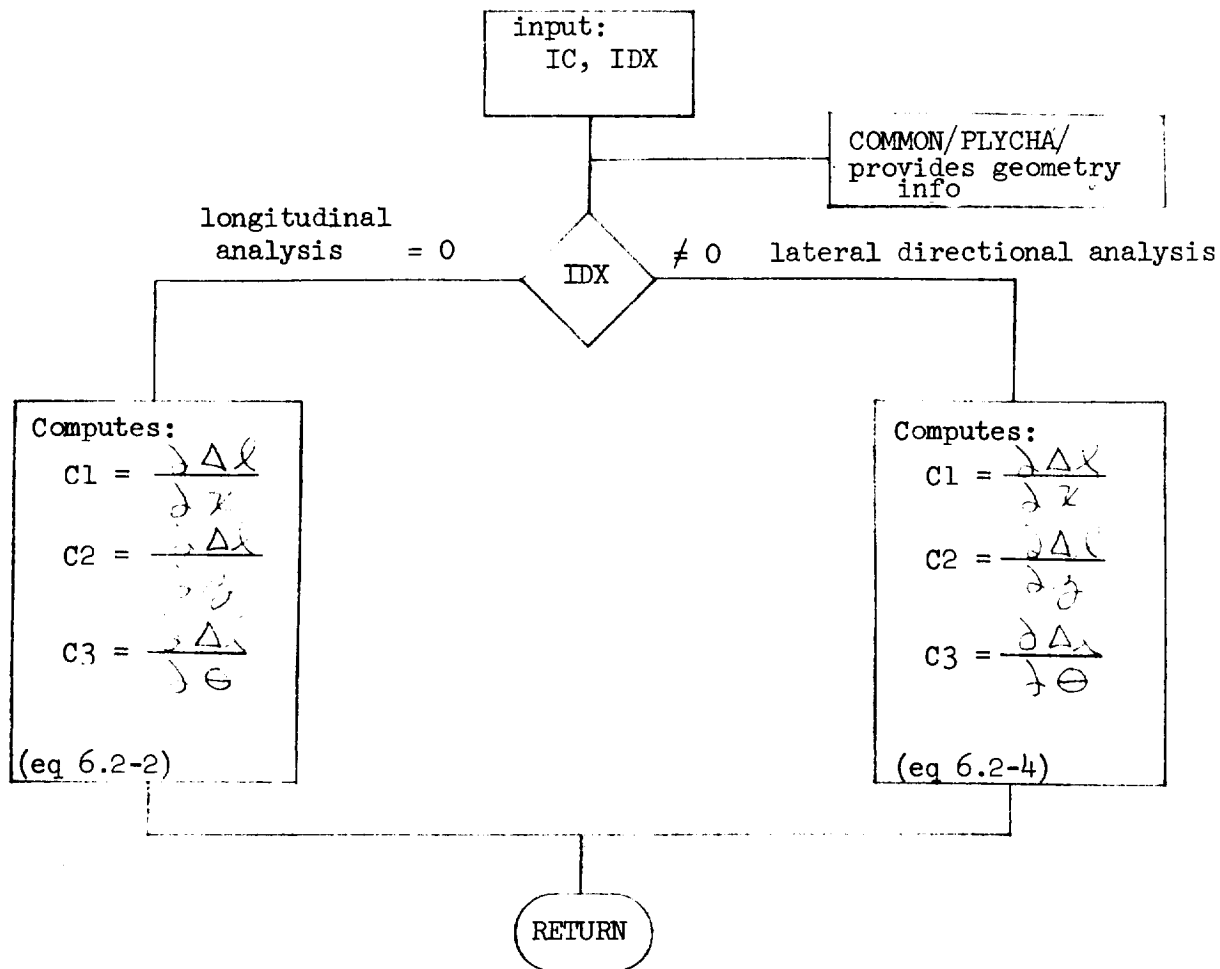


FIGURE 6.4 - FLOW CHART - SUBROUTINE LONG



IC = cable no.,

- 1 - front upper or front starboard pulley
- 2 - front lower or front port-side pulley
- 3 - rear upper or rear starboard pulley
- 4 - rear lower or rear port-side pulley
- 5 - anti-lift cable

FIGURE 6.5 - FLOW CHART - SUBROUTINE DLGTH

7.0 Lateral Directional Stability Analysis

7.1 Subroutine LAT

This subroutine computes the forces and moments for the perturbed lateral/directional equations of motion and extracts the characteristic roots for the stability analysis.

The equations of motion, equation 5.1-14, are reduced to 7.1-1 for the lateral/directional analysis.

$$\begin{aligned}\Sigma \Delta F_y &= m \ddot{y} \\ \Sigma \Delta M_x &= \ddot{\phi} I_x + \dot{\psi} I_{xz} \\ \Sigma \Delta M_z &= \ddot{\psi} I_z - \dot{\phi} I_{xz}\end{aligned}\tag{7.1-1}$$

where

$$\begin{aligned}\Sigma \Delta F_y &= \Delta F_{y_{aero}} + \Delta F_{y_{cable}} + \Delta W_y \\ \Sigma \Delta M_x &= \Delta L_{aero} + \Delta L_{cable} + \Delta L_{WGT} \\ \Sigma \Delta M_z &= \Delta N_{aero} + \Delta N_{cable} + \Delta L_{WGT}\end{aligned}\tag{7.1-2}$$

y , ψ and ϕ represent lateral/directional perturbation variables:

The aerodynamic forces and moments, $\Delta F_{y_{aero}}$, ΔL_{aero} and ΔN_{aero} are defined by equations 5.3-3.2, 5.3-3.4 and 5.3-3.6 respectively. The generalized weight contributions are defined by equations 5.2-7 and 5.2-9. The expressions are simplified with x , z and $\theta = 0$.

$$\begin{aligned}\Delta W_y &= \left[W \sin \theta_o \psi + W \cos \theta_o \phi \right] - m \left[XCG \ddot{\psi} - ZCG \ddot{\phi} \right] \\ \Delta L_{WGT} &= -ZCG \left[(W \sin \theta_o \psi + W \cos \theta_o \phi) - m \dot{y} \right] \\ \Delta N_{WGT} &= XCG \left[(W \sin \theta_o \psi + W \cos \theta_o \phi) - m \dot{y} \right]\end{aligned}\tag{7.1-3}$$

The cable forces and moments are determined by equations 5.4-6 and 5.4-8. These equations reduce to equation 7.1-4 for x , z and θ zero.

$$\Delta F_I = \Delta F_{T_2} - \Psi F_{To_1} + \phi F_{To_3} \quad (7.1-4)$$

$$\Delta L_I = \left(y_p \Delta F_{T_3} - z_p \Delta F_{T_2} \right) + z_p F_{To_1} \Psi - \left(y_p F_{To_2} + z_p F_{To_3} \right) \phi$$

$$\Delta N_I = \left(x_p \Delta F_{T_2} - y_p \Delta F_{T_1} \right) - \left(x_p F_{To_1} + y_p F_{To_2} \right) \Psi + \left(x_p F_{To_3} \right) \phi$$

The F_{To} and ΔF_T components are defined by equations 5.4-3.2 and 5.4-3.3:

$$F_{To_i} = T \cos \alpha_i - T \Delta \alpha_i \sin \alpha_i \quad (5.4-3.2)$$

$$\Delta F_{T_i} = \Delta T_i \cos \alpha_i - T \Delta \alpha_i \sin \alpha_i \quad (5.4-3.3)$$

The steady state terms, T and α_i , are determined by the trim analysis. The perturbation terms, ΔT_i and $\Delta \alpha_i$, are proportional to y , Ψ and ϕ . In the lateral directional analysis, the rear cable tension, ΔT_{R_i} , is assumed proportional to the change in rear cable length.

$$\Delta T_{R_i} = AKR (\Delta \ell_3 + \Delta \ell_4) \quad (7.1-5)$$

The perturbed front cable tension, ΔT_{F_i} , is assumed to be zero in the analysis. The perturbed cable length, $\Delta \ell_i$, and cable direction cosine, $\Delta \alpha_i$, are computed in subroutines DLGTH and DCOSD respectively. These routines are described in Sections 6.2 and 7.2.

For each cable, the force and moment equations are reduced to functions of y , Ψ and ϕ via the subroutine MASH. The results are then summed for all cables in the FXS array. The final FXS array is the lateral/directional cable influence matrix. The form of the initial matrix prior to using MASH is shown in Figure 7.1.

Subsequent to computing the cable matrix, the lateral/directional stability characteristic matrix is generated. Figure 7.2 shows the elements of the matrix and the expanded equations of motion which it represents. A routine which reduces the matrix to a characteristic polynomial and extracts the characteristic roots is applied to the matrix at this point.

A functional flow diagram is presented in Figure 7.3.

7.2 Subroutine DCOSD.

This program computes the $\Delta\alpha$ vector components required by subroutine LAT. The vector components are derived from the generalized formulation in equation 5.4-18.

With x , z , and θ equated to zero for the lateral/directional stability analysis, equation 5.4-18 can be expanded to the following form:

$$\Delta\alpha_1 = \left(-\frac{\cos \alpha_2 \cot \alpha_1}{l} \right) y - \left(\frac{y_p \sin \alpha_1 + x_p \cos \alpha_2 \cot \alpha_1}{l} \right) \psi + \left(\frac{z_p \cos \alpha_2 \cot \alpha_1 - y_p \cos \alpha_2 \cot \alpha_1}{l} \right) \phi \quad (7.2-1)$$

$$\Delta\alpha_2 = \frac{\sin \alpha_2}{l} y + \left(\frac{y_p \cos \alpha_1 \cot \alpha_2 + x_p \sin \alpha_2}{l} \right) \psi - \left(\frac{z_p \sin \alpha_2 + y_p \cos \alpha_3 \cot \alpha_2}{l} \right) \phi \quad (7.2-2)$$

$$\Delta\alpha_3 = \left(-\frac{\cos \alpha_2 \cot \alpha_3}{l} \right) y + \left(\frac{y_p \cos \alpha_1 \cot \alpha_3 - x_p \cos \alpha_2 \cot \alpha_3}{l} \right) \psi + \left(\frac{z_p \cos \alpha_2 \cot \alpha_3 + y_p \sin \alpha_3}{l} \right) \phi \quad (7.2-3)$$

The program thus generates an array of nine elements, three elements for each of the three vectors.

LATERAL DISTORTIONAL CABLE MATRIX

	y	ψ	ϕ	ΔT	$\Delta \alpha_1$	$\Delta \alpha_2$	$\Delta \alpha_3$	z
①		$-T \cos \alpha_1$	$T \cos \alpha_3$	$\cos \alpha_2$		$-T \sin \alpha_2$		
②		$-x_p T \cos \alpha_1 - y_p T \cos \alpha_2$	$x_p T \cos \alpha_3$	$x_p \cos \alpha_2 - y_p \cos \alpha_1$	$y_p T \sin \alpha_1$	$-x_p T \sin \alpha_2$		
③		$z_p T \cos \alpha_1$	$-z_p T \cos \alpha_3 - y_p T \cos \alpha_2$	$y_p \cos \alpha_3 - z_p \cos \alpha_2$		$z_p T \sin \alpha_2$	$y_p T \sin \alpha_3$	
④				-1				AKR
⑤	$\Delta \alpha_1 y$	$\Delta \alpha_1 \psi$	$\Delta \alpha_1 \phi$		-1			
⑥	$\Delta \alpha_2 y$	$\Delta \alpha_2 \psi$	$\Delta \alpha_2 \phi$			-1		
⑦	$\Delta \alpha_3 y$	$\Delta \alpha_3 \psi$	$\Delta \alpha_3 \phi$				-1	
⑧	Δl_y	$\Delta l \psi$	$\Delta l \phi$					-1

EQUATIONS: ① $\Delta F_{I2} = \Delta F_{T2} - F_{T01} \psi + F_{T03} \phi = (\Delta T \cos \alpha_2 - \Delta \alpha_2 T \sin \alpha_2) - T \cos \alpha_1 \psi + T \cos \alpha_3 \phi$ (eq 7.1-4)

② $\Delta N_I = (x_p \Delta F_{T2} - y_p \Delta F_{T1}) - (x_p F_{T01} + y_p F_{T02}) \psi + x_p F_{T03} \phi = [x_p (\Delta T \cos \alpha_2 - \Delta \alpha_2 T \sin \alpha_2) - y_p (\Delta T \cos \alpha_1 - \Delta \alpha_1 T \sin \alpha_1)]$

$- [x_p T \cos \alpha_1 + y_p T \cos \alpha_2] \psi + x_p T \cos \alpha_3 \phi$ (eq 7.1-4)

③ $\Delta L_I = (y_p \Delta F_{T3} - z_p \Delta F_{T2}) + z_p F_{T01} \psi - (y_p F_{T02} + z_p F_{T03}) \phi = [y_p (\Delta T \cos \alpha_3 - \Delta \alpha_3 T \sin \alpha_3) - z_p (\Delta T \cos \alpha_2 - \Delta \alpha_2 T \sin \alpha_2) + z_p T \cos \alpha_1 \psi - [y_p T \cos \alpha_2 + z_p T \cos \alpha_3] \phi$ (eq 7.1-4)

④ $\Delta T_F = 0$, $\Delta T_R = AKR (\Delta l_3 + \Delta l_4)$ (eq 7.1-5)

⑤ $\Delta \alpha_1 = \Delta \alpha_1 y \psi + \Delta \alpha_1 \psi \psi + \Delta \alpha_1 \phi \phi$ (eq 7.2-1)

⑥ $\Delta \alpha_2 = \Delta \alpha_2 y \psi + \Delta \alpha_2 \psi \psi + \Delta \alpha_2 \phi \phi$ (eq 7.2-2)

⑦ $\Delta \alpha_3 = \Delta \alpha_3 y \psi + \Delta \alpha_3 \psi \psi + \Delta \alpha_3 \phi \phi$ (eq 7.2-3)

⑧ $\Sigma l = \Delta l y \psi + \Delta l \psi \psi + \Delta l \phi \phi = (\Delta l_3 y + \Delta l_4 y) \psi + (\Delta l_3 \psi + \Delta l_4 \psi) \psi + (\Delta l_3 \phi + \Delta l_4 \phi) \phi$ (eq 6.2-4)

FIG. 7.1 - MATRIX

LATERAL DIRECTIONAL CHARACTERISTICS MATRIX & EQUATIONS

ξ	ψ	ϕ
$m A^2 - \left(\frac{\partial Y_A}{\partial \beta} \frac{1}{V_0} + \frac{\partial Y_{S_n}}{\partial \dot{y}} \right) A - \frac{\partial Y_c}{\partial \dot{y}}$	$m X_{c_0} A^2 - \left(\frac{\partial Y_A}{\partial r} + \frac{\partial Y_{c_n}}{\partial \dot{r}} \right) A + \left(\frac{\partial Y_A}{\partial \dot{c}} - \frac{\partial Y_c}{\partial \dot{y}} \right) \dot{c}$	$-m Z_{c_0} A^2 - \left(\frac{\partial Y_A}{\partial p} + \frac{\partial Y_{S_n}}{\partial \dot{p}} \right) A - \left(\frac{\partial Y_c}{\partial \dot{p}} + m C_{S_n} \dot{c} \right)$
$m X_{c_0} A^2 - \left(\frac{\partial N_A}{\partial \beta} \frac{1}{V_0} + \frac{\partial N_{S_n}}{\partial \dot{y}} \right) A - \frac{\partial N_c}{\partial \dot{y}}$	$I_{xz} A^2 - \left(\frac{\partial N_A}{\partial r} + \frac{\partial N_{S_n}}{\partial \dot{r}} \right) A + \left(\frac{\partial N_A}{\partial \dot{c}} - \frac{\partial N_c}{\partial \dot{y}} - X_{c_0} m \dot{c} \right)$	$-I_{xz} A^2 - \left(\frac{\partial N_A}{\partial p} + \frac{\partial N_{S_n}}{\partial \dot{p}} \right) A - \left(\frac{\partial N_c}{\partial \dot{p}} - X_{c_0} m C_{S_n} \dot{c} \right)$
$-m Z_{c_0} A^2 - \left(\frac{\partial L_A}{\partial \beta} \frac{1}{V_0} + \frac{\partial L_{S_n}}{\partial \dot{y}} \right) A - \frac{\partial L_c}{\partial \dot{y}}$	$-I_{xz} A^2 - \left(\frac{\partial L_A}{\partial r} + \frac{\partial L_{S_n}}{\partial \dot{r}} \right) A + \left(\frac{\partial L_A}{\partial \dot{c}} - \frac{\partial L_c}{\partial \dot{y}} - Z_{c_0} m \dot{c} \right)$	$I_{rx} A^2 - \left(\frac{\partial L_A}{\partial p} + \frac{\partial L_{S_n}}{\partial \dot{p}} \right) A - \left(\frac{\partial L_c}{\partial \dot{p}} + Z_{c_0} m C_{S_n} \dot{c} \right)$

Y-Force Equation:

$$m \ddot{y} = \frac{\partial Y_A}{\partial \beta} \beta + \frac{\partial Y_A}{\partial r} \dot{\psi} + \frac{\partial Y_A}{\partial p} \dot{\phi} + W \sin \theta_0 \phi + m Z_{c_0} \ddot{\psi} + m Z_{c_0} \ddot{\phi} + \frac{\partial Y_c}{\partial \dot{y}} \dot{y} + \frac{\partial Y_c}{\partial \dot{\psi}} \dot{\psi} + \frac{\partial Y_{S_n}}{\partial \dot{p}} \dot{\phi} + \frac{\partial Y_{S_n}}{\partial \dot{c}} \dot{c}$$

Aero

Weight

Cable Spring Force

Subble Damping Force

Yaw Moment Equation:

$$I_{xz} \ddot{\psi} - I_{xz} \ddot{\phi} = \frac{\partial M_A}{\partial \beta} \beta + \frac{\partial M_A}{\partial r} \dot{\psi} + \frac{\partial M_A}{\partial p} \dot{\phi} + X_{c_0} (W \sin \theta_0 - W \cos \theta_0) - m X_{c_0} \ddot{y} + \frac{\partial M_c}{\partial \dot{y}} \dot{y} + \frac{\partial M_c}{\partial \dot{\psi}} \dot{\psi} + \frac{\partial M_{S_n}}{\partial \dot{p}} \dot{\phi} + \frac{\partial M_{S_n}}{\partial \dot{c}} \dot{c}$$

Aero Mom

Weight Mom

Cable Spring Moment

Subble Damping Moment

Roll Moment Equation:

$$I_{rx} \ddot{\phi} - I_{xz} \ddot{\psi} = \frac{\partial L_A}{\partial \beta} \beta + \frac{\partial L_A}{\partial r} \dot{\psi} + \frac{\partial L_A}{\partial p} \dot{\phi} + Z_{c_0} (W \cos \theta_0 + W \sin \theta_0) + m Z_{c_0} \ddot{y} + \frac{\partial L_c}{\partial \dot{y}} \dot{y} + \frac{\partial L_c}{\partial \dot{\psi}} \dot{\psi} + \frac{\partial L_{S_n}}{\partial \dot{p}} \dot{\phi} + \frac{\partial L_{S_n}}{\partial \dot{c}} \dot{c}$$

Aero Mom

Weight Mom

Cable Spring Moment

Subble Damping Moment

Auxiliary Equation

$$\dot{\beta} = \psi + \frac{\dot{y}}{V_0}$$

$$\dot{\phi} = \dot{\psi} + \frac{\dot{y}}{V_0}$$

FIG. 7.2 - MATRIX

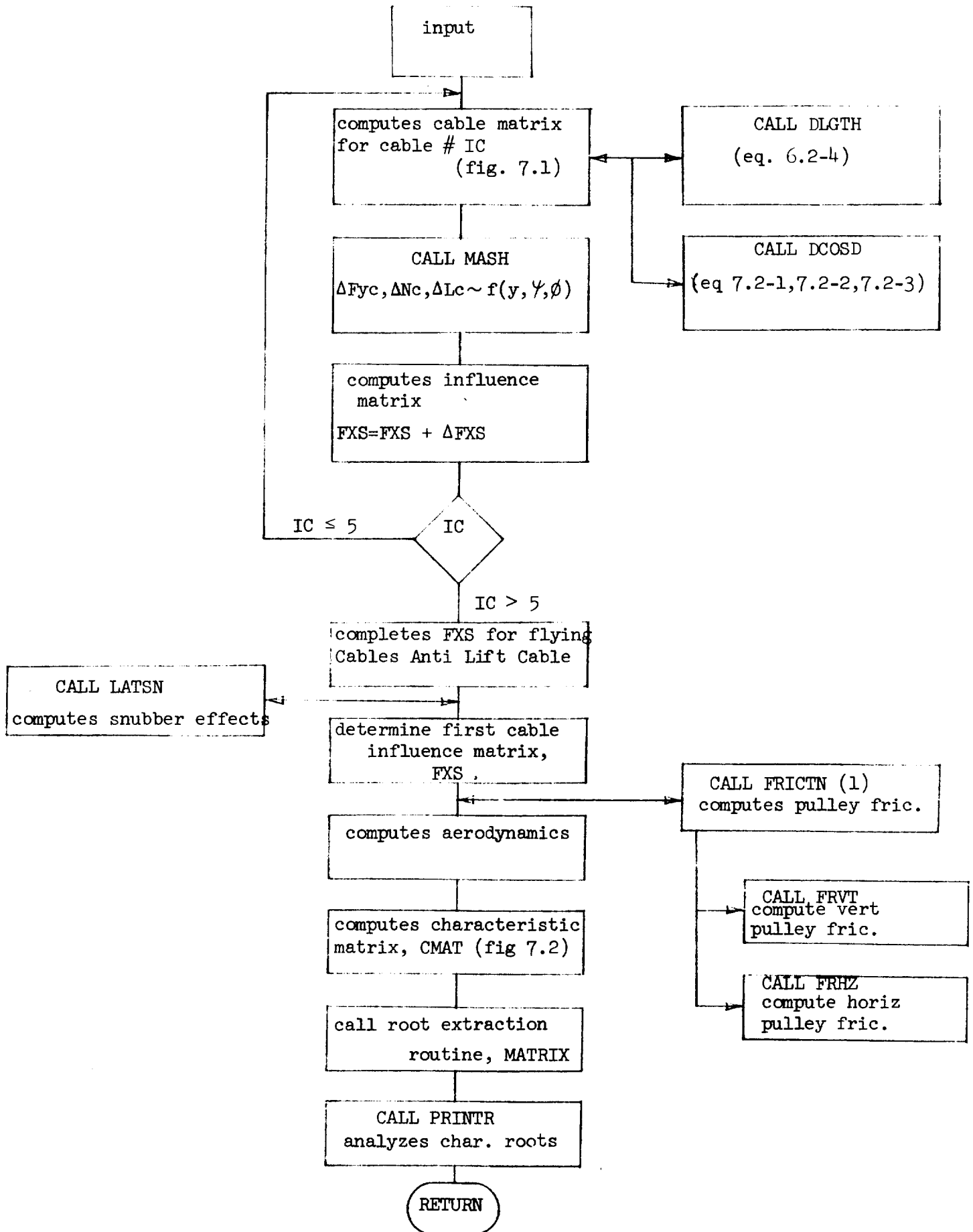


FIGURE 7.3 - FLOW CHART - SUBROUTINE LAT.

8.0 MODELING SNUBBER EFFECTS

8.1 SNUBBER SNUBBED EFFECTS

8.1.1 TRIM EFFECTS

The effects of the snubbers on model trim are introduced as FXSN, FZSN and AMSN into the TRIM subroutine. These terms are calculated in subroutine SNTRM. The expressions for modeling these effects are identical to those used for the flying cables. The direction cosines for each snubber cable are generated in subroutine DRSCN with the resulting force and moment contributions being defined in terms of these angles.

The following derivation of one set of direction cosines for the upper right cable applies to all snubber cables. See Figure 11.3 for a definition of terms.

Calculate linear components from equation reference center to snubber tie down at the tunnel wall:

$$X_{T_1} = STACR - SNUST$$

$$Z_{T_1} = WLCR - SNUWL$$

$$Y_{T_1} = - SNUBL$$

transforming to body axis:

$$X_{B_1} = X_{T_1} \cos \theta - Z_{T_1} \sin \theta$$

$$Z_{B_1} = X_{T_1} \sin \theta + Z_{T_1} \cos \theta$$

$$Y_{B_1} = Y_{T_1}$$

Finding linear components from model tie down point to tunnel side wall:

$$X_B = X_{B_1} + \text{SNUX}$$

$$Y_B = Y_{B_1} + \text{SNUY}$$

$$Z_B = Z_{B_1} + \text{SNUZ}$$

The linear distance is then:

$$L = \sqrt{X_B^2 + Y_B^2 + Z_B^2}$$

The direction cosines are:

$$\gamma_x = X_B/L \quad \gamma_y = Y_B/L \quad \gamma_z = Z_B/L$$

resulting in the angles being:

$$\alpha_x = \cos^{-1} \gamma_x, \quad \alpha_y = \cos^{-1} \gamma_y, \quad \alpha_z = \cos^{-1} \gamma_z$$

Assuming top and bottom cables to be symmetric with respect to the X-Z plane, the following force and moment equations define the terms necessary to determine trim.

$$F_{X_{up}} = 2 T_{up} \cos \alpha_{x_u}$$

$$F_{X_{low}} = 2 T_{low} \cos \alpha_{x_l}$$

$$F_{Z_{up}} = 2 T_{up} \cos \alpha_{z_u}$$

$$F_{Z_{low}} = 2 T_{low} \cos \alpha_{z_l}$$

$$M_{up} = (-\text{SNUZ}) F_{X_{up}} + (\text{SNUX}) F_{Z_{up}}$$

$$M_{low} = (\text{SNLZ}) F_{X_{low}} + (\text{SNLX}) F_{Z_{low}}$$

or:

$$F_x = F_{x_{up}} + F_{x_{low}} = \text{FXSN}$$

$$F_z = F_{z_{up}} + F_{z_{low}} = \text{FZSN}$$

$$M = M_{up} + M_{low} = \text{AMSN}$$

A flow chart of subroutine SNTRM is shown in Figure 8.1.

8.1.2

STABILITY EFFECTS

The effects of the snubbed snubbers on both longitudinal and lateral stability are modeled similar to the rear flying cables. These effects are calculated in subroutines LONGSN and LATSN and inserted into subroutines LONG and LAT as additional terms (SNU, SNUD) in the polynomial matrix describing the system. Each cable is modeled independently, the terms effecting each cable are summed up and the results, contained in the SNU array, are combined with the flying cable effects in the CMAT array. Since the theoretical derivation of these terms is similar to the rear flying cables, the derivation here will be abbreviated.

The major difference in the derivation is the calculation of the change in tension. For the rear flying cables the cable tension change was defined as:

$$\Delta T = K \Delta L$$

The snubber cables have an added damping effect resulting in the following equation:

$$\Delta T = K \Delta L + D \dot{\Delta L}$$

The damping term is added to the polynomial matrix CMAT through the array SNUD.

Flow charts for subroutines LONGSN and LATSN are shown in Figures 8.2 and 8.3.

8.1.2.1

LONGITUDINAL STABILITY EFFECTS

Due to symmetry the longitudinal effects of the top snubbers are modelled simultaneously and similarly the bottom cables can be modelled together. Only the top cable derivation will be presented here. See Figure 11.3 for a pictorial representation of the snubbers.

The total force and moment equations from Section 5.0 are:

$$\Sigma F_x = 2 (T + \Delta T) \cos (\alpha_x + \Delta\alpha_x) - (2T \cos\alpha_z) \theta$$

$$\Sigma F_z = 2 (T + \Delta T) \cos (\alpha_z + \Delta\alpha_z) + (2T \cos\alpha_x) \theta$$

$$\Sigma M = (SNUZ) (-F_x) + (SNUX) F_z$$

Defining perturbation terms:

$$\Delta T = K \Delta L + D \dot{\Delta L}$$

and from Section 5.0:

$$\begin{aligned} \Delta\alpha_x = & \left[\frac{-SNUX \sin \alpha_x}{ALU} + \left(\frac{-SNUX}{ALU} \right) \cos \alpha_z \cot \alpha_x \right] \theta \\ & + \left[\frac{\sin \alpha_x}{ALU} \right] x + \left[\frac{-\cos \alpha_z \cot \alpha_x}{ALU} \right] z \\ \Delta\alpha_z = & \left[\frac{SNUZ \cos \alpha_x \cot \alpha_z}{ALU} + \left(\frac{-SNUX}{ALU} \right) \sin \alpha_z \right] \theta + \left[\frac{\sin \alpha_z}{ALU} \right] z \\ & + \left[\frac{-\cos \alpha_x \cot \alpha_z}{ALU} \right] x \end{aligned}$$

$$\begin{aligned} \Delta L = & \left[-\cos \alpha_x \right] x + \left[(-SNUX + (ALU) \cos \alpha_x) \cos \alpha_z \right. \\ & \left. - (-SNUZ + (ALU) \cos \alpha_z) \cos \alpha_x \right] \theta - \left[\cos \alpha_z \right] z \end{aligned}$$

These equations are set in a 7 x 7 matrix with the following form:

$$\begin{bmatrix} \Sigma F_x & & & & & & \\ \Sigma F_z & & & & & & \\ \Sigma M & & & & & & \\ & -1 & & & & & \\ & & -1 & & & & \\ & & & -1 & & & \\ & & & & -1 & & \end{bmatrix} \begin{bmatrix} x \\ z \\ \theta \\ \Delta\alpha_x \\ \Delta\alpha_z \\ \Delta T \\ \Delta L \end{bmatrix} = 0$$

This matrix is reduced to a 3 x 3 matrix in x, z and θ . The first order terms are contained in the 3 x 3 array FTOP and the damping terms (second order) are contained in the array SNUD.

A similar procedure is followed for the effects of the bottom cables. The terms for each set of cables are then combined and added to the longitudinal stability matrix through the arrays SNU and SNUD.

8.1.2.2 LATERAL STABILITY EFFECTS

The lateral stability effects of the snubbers are modeled for each cable individually and the results summed up. The procedure is similar to the longitudinal case. Only the top right cable terms will be shown here. The effects for the other cables are similar.

Force and moment equations are:

$$F_y = (T + \Delta T) \cos(\alpha_y + \Delta\alpha_y) - (T \cos \alpha_x) \Psi + (T \cos \alpha_z) \phi$$

$$\Sigma N = (-SNUX) F_y + (SNUY) F_x$$

$$\Sigma L = (-SNUY) F_z + (SNUZ) F_y$$

expanding the equations and dropping the steady state terms:

$$\Sigma \Delta F_y = \Delta T \cos \alpha_y - T \sin \alpha_y \Delta \alpha_y - \Psi T \cos \alpha_x + T \cos \alpha_z \phi$$

$$\Sigma \Delta N = (-SNUX) \Delta F_y + SNUY \left[\Delta T \cos \alpha_x - T \sin \alpha_x \Delta \alpha_x \right]$$

$$\Sigma \Delta L = (SNUZ) \Delta F_y - SNUY \left[\Delta T \cos \alpha_z - T \sin \alpha_z \Delta \alpha_z \right]$$

Defining ΔT , ΔL , $\Delta \alpha_x$, $\Delta \alpha_y$, $\Delta \alpha_z$:

$$\Delta T = K \Delta \ell + D \dot{\Delta \ell}$$

From Section 5.0:

$$\begin{aligned}
\Delta l &= \left[-\cos \alpha_y \right] Y + \left[(-\text{SNUZ}) \cos \alpha_y + (\text{SNUY}) \cos \alpha_z \right] \phi \\
&\quad + \left[(-\text{SNUY}) \cos \alpha_x + (\text{SNUX}) \cos \alpha_y \right] \psi \\
\Delta \alpha_x &= \left[\frac{(-\text{SNUY}) \sin \alpha_x - (\text{SNUX}) \cos \alpha_y \cot \alpha_x}{\text{ALU}} \right] \psi \\
&\quad + \left[\frac{(-\text{SNUZ}) \cos \alpha_y \cot \alpha_x + \text{SNUY} \cos \alpha_z \cot \alpha_x}{\text{ALU}} \right] \phi \\
&\quad + \left[\frac{-\cos \alpha_y \cot \alpha_x}{\text{ALU}} \right] Y \\
\Delta \alpha_y &= \left[\frac{(-\text{SNUY}) \cos \alpha_y \cot \alpha_y - (\text{SNUX}) \sin \alpha_y}{\text{ALU}} \right] \psi + \left[\frac{\sin \alpha_y}{\text{ALU}} \right] Y \\
&\quad - \left[\frac{(-\text{SNUZ}) \sin \alpha_y - (\text{SNUY}) \cos \alpha_z \cot \alpha_y}{\text{ALU}} \right] \phi \\
\Delta \alpha_z &= \left[\frac{(-\text{SNUY}) \cos \alpha_x \cot \alpha_z + (\text{SNUX}) \cos \alpha_y \cot \alpha_z}{\text{ALU}} \right] \psi \\
&\quad + \left[\frac{(-\text{SNUZ}) \cos \alpha_y \cot \alpha_z - (\text{SNUY}) \sin \alpha_z}{\text{ALU}} \right] \phi - \left[\frac{\cos \alpha_y \cot \alpha_z}{\text{ALU}} \right] Y
\end{aligned}$$

These equations are set in a 8 x 8 matrix with the following form:

$$\begin{bmatrix}
\Sigma F_y \\
\Sigma \Delta N \\
\Sigma \Delta L \\
-1 \\
-1 \\
-1 \\
-1 \\
-1
\end{bmatrix}
\begin{bmatrix}
Y \\
\psi \\
\phi \\
\Delta \alpha_x \\
\Delta \alpha_y \\
\Delta \alpha_z \\
\Delta T \\
\Delta l
\end{bmatrix}
= 0$$

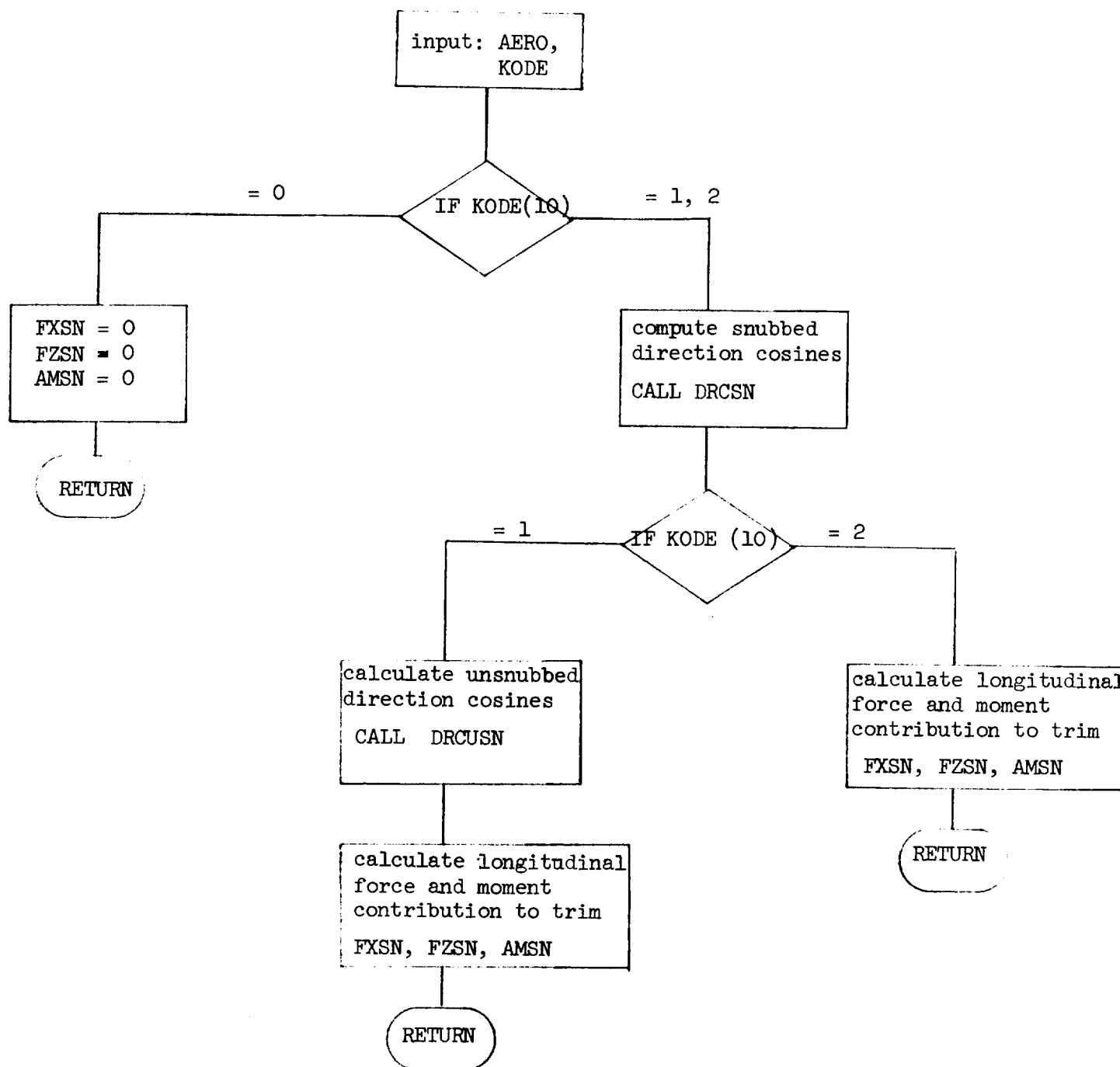


FIGURE 8.1 - FLOW CHART - SUBROUTINE SNTRM

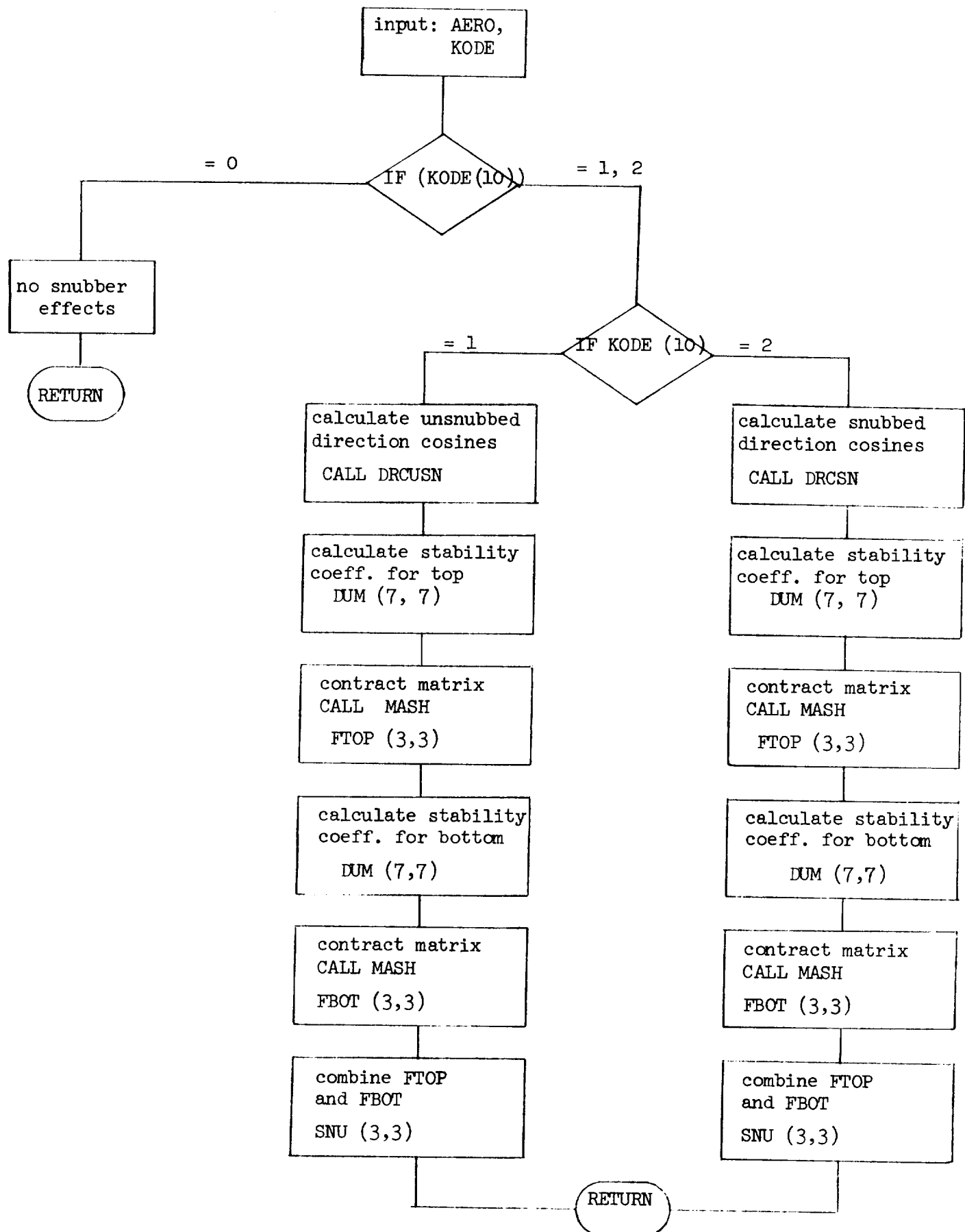


FIGURE 8.2 - FLOW CHART - SUBROUTINE LONGSN

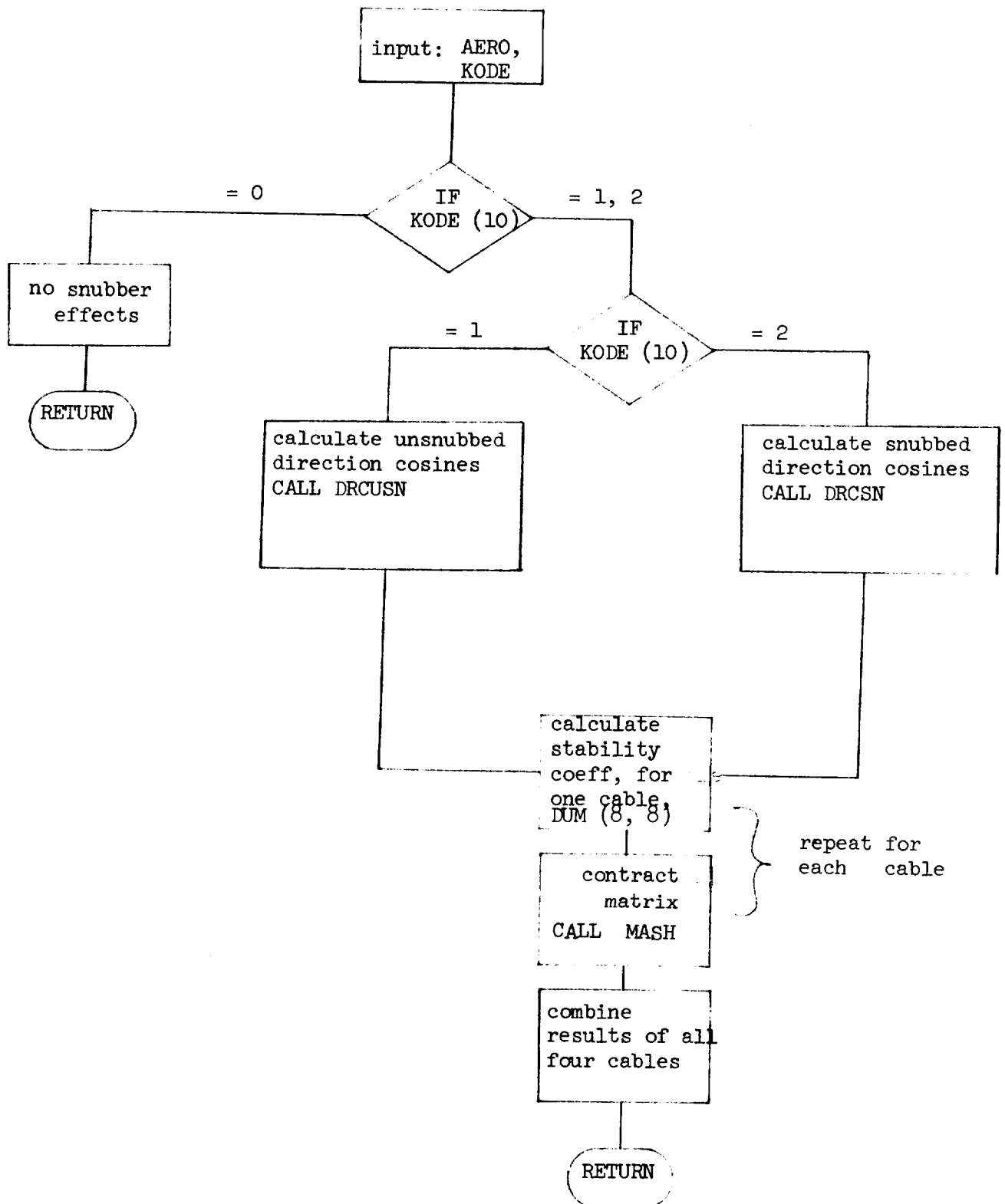


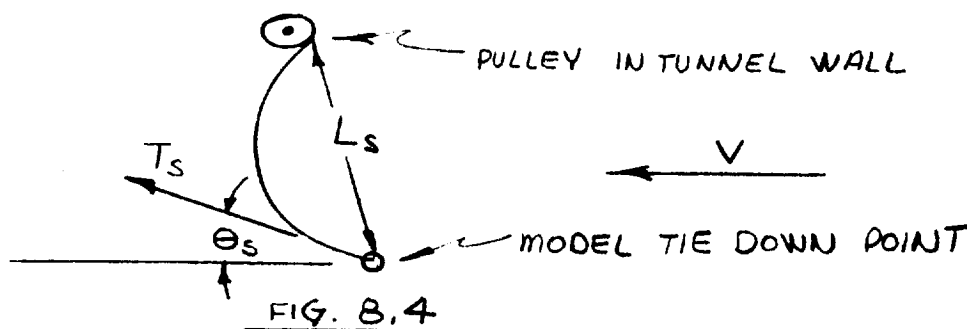
FIGURE 8.3 - FLOW CHART - SUBROUTINE LATSN

This matrix is reduced to a 3 x 3 matrix in y , Ψ and ϕ . A similar procedure is used to derive the contributions of the other three cables. The effects of all cables are added and introduced in the lateral stability matrix as SNU and SNUD.

8.2 UNSNUBBED SNUBBER EFFECTS

8.2.1 TRIM EFFECTS

The effects of the unsnubbed snubbers are modeled similar to the snubbed case except for the calculation of the direction cosines and the effective spring constant for each cable. The direction cosines for each slack cable are calculated in subroutine DRCUSN using the data from Table 1. This table contains a record of the true angle (θ_s) between the unsnubbed cable at the model tie down point and the tunnel negative X axis vs. dynamic pressure and linear distance (L_s) between model and tunnel wall tie down points. This function is shown graphically below.



L_s = true linear distance between the model tie-down and side wall pulley.

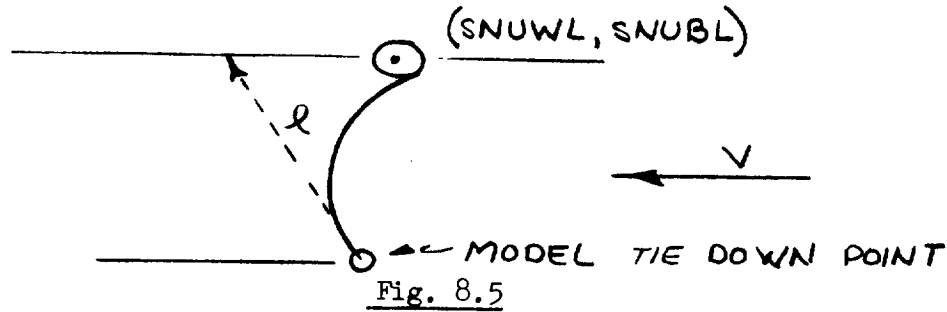
θ_s = angle made between the slack cable and the tunnel centerline.

T_s = tension in cable at tie-down point.

The direction cosines are derived below for the top right snubber in the unsnubbed condition. The other three cables are similarly derived. Referring to Figure 8.4, the angle the cable makes with the X-axis is:

$$\alpha_x = - \cos^{-1} (\theta_s)$$

The Y and Z axis angles are derived from the theoretical length of a vector originating at the model tie-down point, intercepting the tunnel side wall and running parallel to the force vector shown below.

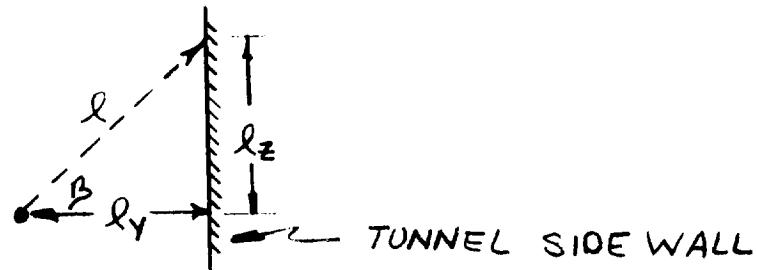


The Y and Z components of this vector are:

$$l_z = SNUWL - (WLCR + SNUZ - SNUX \sin \theta)$$

$$l_y = SNUBL - (BLCR + SNUY)$$

A front view of this vector shows:



from which: $\theta = \tan^{-1} l_z / l_y$

The theoretical length of the vector is then:

$$l = l_y / (\sin \theta_s) (\cos \beta)$$

which implies the direction cosines are:

$$\gamma_y = l_y / l \quad \alpha_y = \cos^{-1} \gamma_y$$

$$\gamma_z = l_z / l \quad \alpha_z = \cos^{-1} \gamma_z$$

These angles are in the tunnel axis system, converting to model body axis:

$$\alpha_{x_1} = \alpha_x \cos \theta - \alpha_z \sin \theta$$

$$\alpha_{y_1} = \alpha_y$$

$$\alpha_{z_1} = \alpha_z \cos \theta + \alpha_x \sin \theta$$

Since top and bottom cables are symmetric with respect to the X-Z plane, the equations shown in Section 8.1.1 can be used once again to describe the longitudinal force and moment contributions to trim.

$$F_x = 2 T_s \cos \alpha_x$$

$$F_z = 2 T_s \cos \alpha_z$$

$$M = (-SNUX) F_x + (SNUX) F_z$$

The tension (T_s) as a function of dynamic pressure and length (L_s) is contained in Table 2.

8.2.2 STABILITY EFFECTS

The effects of the unsnubbed snubbers on longitudinal and lateral/directional stability are modeled exactly as the snubbed case using the direction cosines derived in the previous section. The effective spring constant is calculated by obtaining the local slope of the change in tension (T_s) per change in length (L_s) obtained from Table 2.

$$\Delta T = K \Delta L$$

$$K = \Delta T_s / \Delta L$$

The effects on stability of the unsnubbed snubber are calculated in LONGSN and LATSN and inserted into subroutines LONG and LAT as additional terms (SNU) in the matrices describing the system.

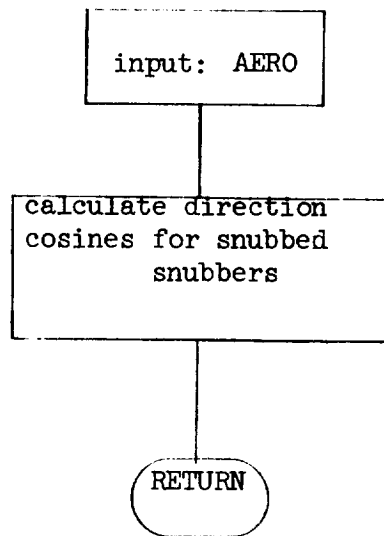
8.2.2.1 LONGITUDINAL STABILITY

Symmetry allows the top cables to be treated together and similarly the bottom cables. The equations are exactly the same as tabulated in Section 8.1.2.1. The direction cosines derived for the slack cable are used in all equations except for the ΔL equation.

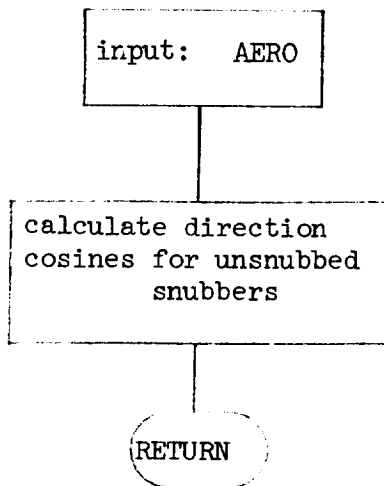
Since the spring constraint is defined in terms of a change in linear distance (L_s), the ΔL must be defined in terms of this length. Therefore the snubbed direction cosines are used for this equation. There are no damping terms ($D \dot{\Delta L}$) associated with the unsnubbed cable.

8.2.2.2 LATERAL STABILITY

These terms are modeled exactly the same as the snubbed case except for the changes described in the preceding section.



SUBROUTINE DRCSN



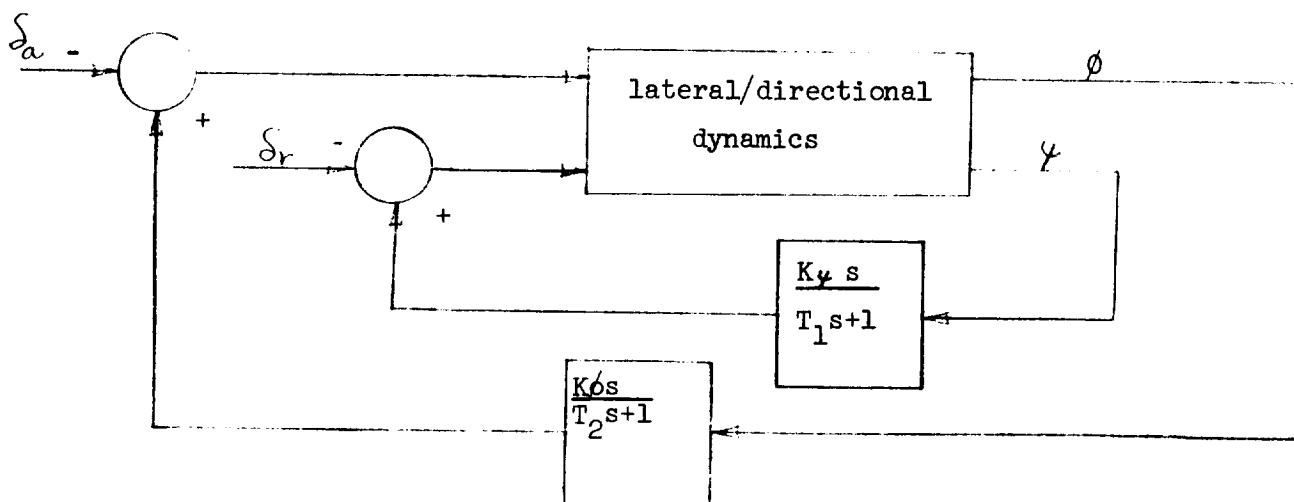
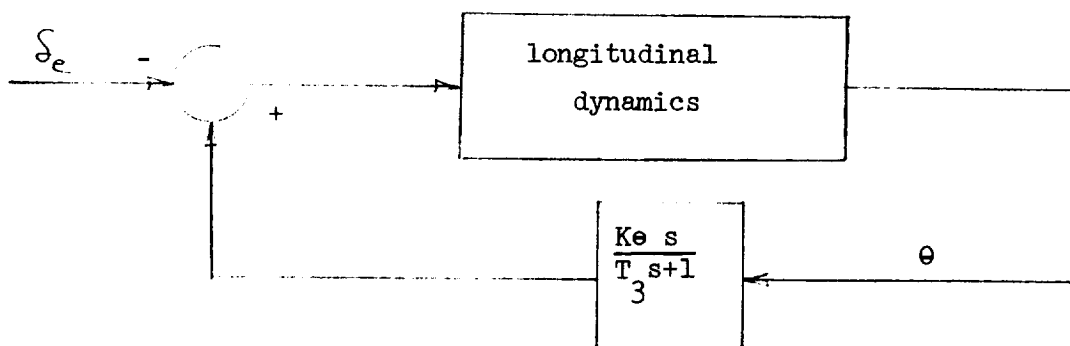
SUBROUTINE DRCUSN

FIGURE 8.6 - FLOW CHART - SUBROUTINE DRCSN, DRCUSN

9.0 DESCRIPTION OF FEEDBACK MODELS

The feedback loops for both the longitudinal and lateral /directional stability analysis are modeled using additional rows and columns in the basic polynomial matrix representation of the dynamics.

The basic feedback elements for which provisions have been made in the program are shown below in block diagram form.



The equations describing the feedbacks are:

$$\delta_e = \frac{K_\theta S}{T_3 S + 1} \theta$$

$$\delta_a = \frac{K_\theta S}{T_1 S + 1} \phi, \quad \delta_r = \frac{K_\psi S}{T_2 S + 1} \psi$$

The basic polynomial matrices are modified as follows to account for the feedback control laws.

Longitudinal:

$$\left[\begin{array}{cc} \text{BASIC} \\ \text{MATRIX} \\ \\ (T_3 S + 1) & (K_\theta S) \end{array} \right] \left[\begin{array}{c} -qSC_{X\delta_e} \\ -qSC_{Z\delta_e} \\ -qSC_{M\delta_e} \\ (T_3 S + 1) \end{array} \right] \left[\begin{array}{c} z \\ \theta \\ \Delta T_F \\ x \\ \delta_e \end{array} \right] = 0$$

Lateral/Directional:

$$\begin{bmatrix}
 \text{BASIC} \\
 \text{MATRIX} \\
 \hline
 K_{\psi} S & & & & & & \\
 & K_{\phi} S & & & & & \\
 & & -T_2 S - 1 & & & & \\
 & & & -T_1 S - 1 & & &
 \end{bmatrix}
 \begin{bmatrix}
 -qSbC_{Y\delta_r} & -qSbC_{Y\delta_a} \\
 -qSbC_{N\delta_r} & -qSbC_{N\delta_a} \\
 -qSbC_{l\delta_r} & -qSbC_{l\delta_a} \\
 & & &
 \end{bmatrix}
 \begin{bmatrix}
 y \\
 \psi \\
 \phi \\
 \delta_r \\
 \delta_a
 \end{bmatrix}
 = 0$$

The longitudinal control law may be evaluated by setting $\text{KODE (8)} = 5$.

The directional control law may be evaluated by the setting $\text{KODE (9)} = 5$.

The lateral plus directional control laws may be evaluated by setting $\text{KODE (9)} = 6$. If no directional loop is to be evaluated, set AERO (123) and AERO (127) equal to 0.

If no control loops are to be considered then $\text{KODE (8)} = 4$ and $\text{KODE (9)} = 3$.

The basic control laws provided in the program (pitch damping, roll damping and yaw damping) can be modified by manually changing the definition of the elements in the 7×7 array 'CMAT' which defines the linearized system dynamics. The procedure is similar to that outlined above. NOTE: The program is limited to 2nd order polynomials. Higher order terms can be handled using state vector modeling.

10.0 PULLEY FRICTION

The assumption is made that the pulley-cable friction is made up of two parts, rolling friction and coulomb friction. Both rolling and coulomb friction combine to create a change in cable tension around the pulley.

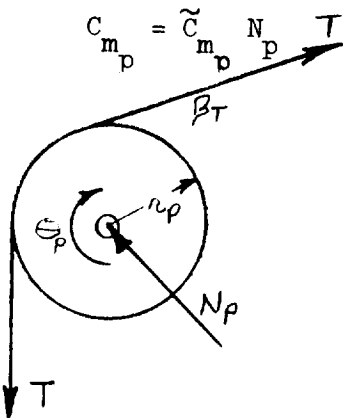
The rolling friction is treated as a linear term and the coulomb friction is linearized using a describing function technique to be described in this section. The terms are calculated in subroutine FRICT and added to the appropriate polynomial matrix through array FRIC.

10.1 ROLLING FRICTION

Rolling friction is described by the rotational damping coefficient, C_{m_p} (ft-#/RPS). The moment transmitted to the model is then:

$$M_{P_R} = \tilde{C}_{m_p} \dot{\theta}_p N_p \quad (10.1-1)$$

where $\dot{\theta}$ is the pulley rotational speed and N_p is the total normal force acting on the pulley.



$$C_{m_p} = \tilde{C}_{m_p} N_p$$

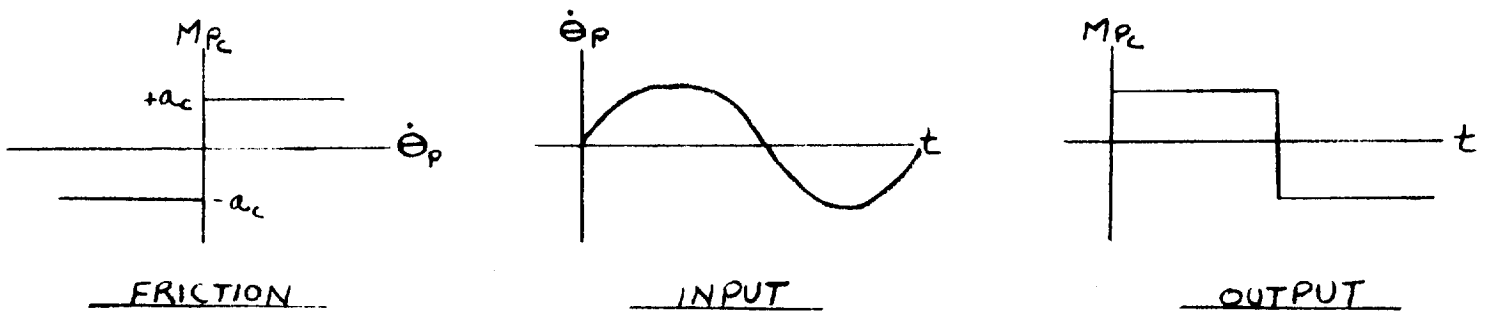
$$N_p = \sqrt{(T - T \sin \beta_T)^2 + (T \cos \beta_T)^2}$$

$$M_{P_R} = \tilde{C}_{M_P} \sqrt{(T - T \sin \beta_T)^2 + (T \cos \beta_T)^2} \dot{\theta}_p$$

10.2 COULOMB FRICTION

Coulomb friction is by definition a non-linear effect where the friction force is of constant magnitude and is always in such a direction as to resist the relative motion. This non-linear effect can be replaced by an 'equivalent' linear effect employing the following reasoning.

First apply a sinusoidal input in $\dot{\theta}_p$ and look at the moment output due to the coulomb friction.



The input can be modeled as:

$$I(t) = \dot{\theta}_p \sin \omega t$$

The output can be modeled as a Fourier series as follows:

$$M(t) = 4a_c/\pi \left[\sin \omega t + 1/3 \sin 3 \omega t + 1/5 \sin 5 \omega t + \dots \right]$$

In terms of transfer functions we then have:

$$I(t) \rightarrow \boxed{G(t)} \rightarrow M(t)$$

or:

$$\left[\dot{\theta}_p \sin \omega t \right] G(t) = 4a_c/\pi \left[\sin \omega t + 1/3 \sin 3 \omega t + 1/5 \sin 5 \omega t + \dots \right]$$

The equivalent linear transfer function is defined as the ratio of the fundamental mode of the output to the input.

$$G(t) = 4a_c/\pi \sin \omega t / \dot{\theta}_p \sin \omega t = 4a_c/\pi \dot{\theta}_p$$

We now have a linear equivalent of the non-linear coulomb friction which is:

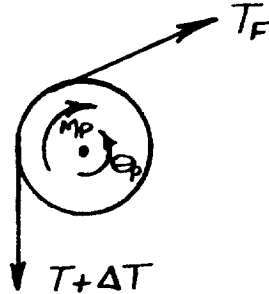
$$M_{Pc} = \frac{4a_c}{\pi} \dot{\theta}_p \quad (10.2-1)$$

a_c is the static opposing force which is a function of wrap angle and normal force. This relationship is empirical and will not be defined in the program. a_c will be input as a constant (AERO (96)) which the user will have to determine.

Combining rolling and coulomb friction, we have the following expression for the total moment.

$$M_p = \begin{bmatrix} \tilde{C}_{M_p} & N_p \end{bmatrix} \dot{\theta}_p + \begin{bmatrix} 4a_c/\pi \end{bmatrix} \dot{\theta}_p \quad (10.2-2)$$

Following the reasoning presented by R. M. Bennett in his write-up, 'Comment On Mount System Damping Based On Pulley Rolling Friction,' the total moment transmitted to the model (M_p) creates an unbalance in cable tension around the pulley.



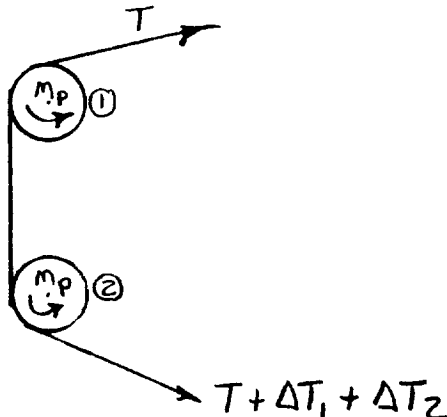
assuming pulley inertia to be negligible, a moment balance produces:

$$\Delta T = M_p / r_p = \begin{bmatrix} \tilde{C}_{M_p} & N_p / r_p \end{bmatrix} \dot{\theta}_p + \begin{bmatrix} 4a_c / \pi r_p \end{bmatrix} \dot{\theta}_p \quad (10.2-3)$$

The resulting forces and moments on the model can now be derived using Bennett's equations.

10.3 PULLEY FRICTION EFFECTS ON LONGITUDINAL AND LATERAL/DIRECTIONAL STABILITY

Only vertical pulleys will effect longitudinal stability. Derivations for both front and rear vertical pulleys follow.



Front Pulley

taking moments around top pulley:

$$\Sigma M = 0$$

$$\Delta T_{r_p} + M_p = 0$$

$$\Delta T_{r_p} - \tilde{C}_{M_p} N_p \dot{\theta}_p - (4a_c/\pi) \theta_p = 0$$

$$\Delta T = \left(\tilde{C}_{M_p} N_p / r_p \right) \dot{\theta}_p + \left(4a_c / \pi r_p \right) \theta_p$$

the pulley rolling in terms of cable length is:

$$\theta_{p1} = - \Delta \ell_1 / r_p \quad \therefore \quad \theta_{p2} = - \Delta \ell_1 / r_p$$

$$\theta_{p1} = - \Delta \dot{\ell} / r_p$$

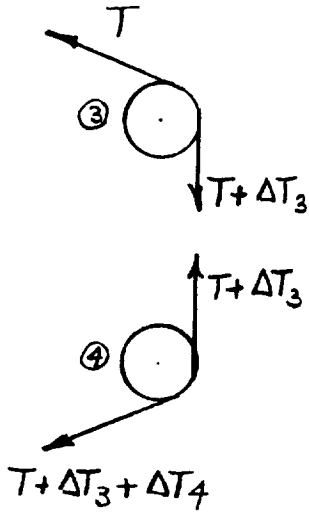
$$\Delta T_{F_1} = \left(\tilde{C}_{M_p} N_p / r_p^2 \right) (- \Delta \ell_1) + \left(4a_c / \pi r_p^2 \right) (- \Delta \ell_1) \quad (10.3-1)$$

a similar approach with the bottom cables yields:

$$\Delta T_{F_2} = \left(\tilde{C}_{M_p} N_p / r_p^2 \right) (\Delta \dot{\ell}_2) + \left(4a_c / \pi r_p^2 \right) (\Delta \ell_2) \quad (10.3-2)$$

$$\begin{aligned} \therefore \Delta T_{\text{FRONT}} = \Delta T_{F_1} + \Delta T_{F_2} &= \left(C_{M_p} N_p / r_p^2 \right) (\Delta \dot{\ell}_2 - \Delta \dot{\ell}_1) + \\ &\quad \left(4a_c / \pi r_p^2 \right) (\Delta \ell_2 - \Delta \ell_1) \end{aligned} \quad (10.3-3)$$

REAR PULLEY



$$\Sigma M = 0 \quad - \Delta T_{r_p} + M_p = 0$$

$$\Delta T_R = M_p / r_p = -\tilde{C}_{M_p} N_p \dot{\theta}_p / r_p - 4a_c \theta_p / \pi r_p$$

$$\theta_{p3} = \Delta \ell_3 / r_p \quad \dot{\theta}_{p3} = \Delta \dot{\ell}_3 / r_p$$

$$\Delta T_3 = \left(-\tilde{C}_{M_p} N_p / r_p^2 \right) \Delta \dot{\ell}_3 - \left(4a_c / \pi r_p^2 \right) \Delta \ell_3 \quad (10.3-5)$$

$$\Delta T_4 = \left(\tilde{C}_{M_p} N_p / r_p^2 \right) \Delta \dot{\ell}_4 + \left(4a_c / \pi r_p^2 \right) \Delta \ell_4 \quad (10.3-6)$$

$$\therefore \Delta T_{\text{REAR}} = \left(\tilde{C}_{M_p} N_p / r_p^2 \right) \left(\Delta \dot{\ell}_4 - \Delta \dot{\ell}_3 \right) + \left(4a_c / \pi r_p^2 \right) (\Delta \ell_4 - \Delta \ell_3) \quad (10.3-7)$$

Since the tension ΔT_{Front} , ΔT_{Rear} is going to act at either the top or the bottom pulley (depending on the direction of motion); and since the arms and direction cosine are inherently different, the effect of these friction contributions is discontinuous about the trim for \pm perturbations in x , z and θ . To eliminate the difficulty, an average arm and direction cosine in the position quadrant is assumed for the action of the forces and moments.

The average direction cosine angles for the front vertical pulleys are:

$$\alpha_x = (\alpha_{21} - \alpha_{11})/2 \quad \alpha_z = \pi/2 - \alpha_x \quad (10.3-8)$$

The average arms for the front vertical pulleys are:

$$\ell_x = (\ell_{1x} - \ell_{1z})/2 \quad \ell_z = (\ell_{2z} - \ell_{1z})/2 \quad (10.3-9)$$

The corresponding set for the rear vertical pulley is:

$$\alpha_x = (\alpha_{41} - \alpha_{31})/2 \quad \ell_x = (\ell_{3x} + \ell_{4x})/2 \quad (10.3-10)$$

$$\alpha_z = \pi/2 - \pi_x \quad \ell_z = (\ell_{4z} - \ell_{3z})/2 \quad (10.3-11)$$

The friction contribution to the ΔF_x , ΔF_z and ΔM for a front and rear vertically configured pulley can be determined.

$$\Delta F_x = \Delta T_{\text{FRONT}} \cos \alpha_{x_F} + \Delta T_{\text{REAR}} \cos \alpha_{x_R} \quad (10.3-12)$$

$$\Delta F_z = \Delta R_{\text{FRONT}} \cos \alpha_{z_F} + \Delta T_{\text{REAR}} \cos \alpha_{z_F} \quad (10.3-13)$$

$$\Delta M_y = \Sigma M_p + \Delta F_x \ell_z - \Delta F_z \ell_x \quad (10.3-14)$$

$$\Sigma M_p = M_{p_F} + M_{p_R}$$

$$M_{p_F} = \left(\tilde{C}_{M_p} \frac{N}{r_p} \right) \left(\dot{\Delta \ell}_2 - \dot{\Delta \ell}_1 \right) + \left(4a_c / \pi r_p \right) \left(\Delta \ell_2 - \Delta \ell_1 \right)$$

$$M_{p_R} = \left(\tilde{C}_{M_p} \frac{N}{r_p} \right) \left(\dot{\Delta \ell}_4 - \dot{\Delta \ell}_3 \right) + \left(4a_c / \pi r_p \right) \left(\Delta \ell_4 - \Delta \ell_3 \right)$$

If either front or rear pulleys are horizontal, there are no friction effects modeled for longitudinal analysis.

Similar expressions can be defined for the front and rear tensions for the lateral/directional analysis. In this case, however, the horizontal pulley configurations are the prime contributor to the perturbation dynamics. The horizontal pulley in the trim condition are symmetric about the x-z plane. Thus, the averaging for the direction cosine and arms process required in the longitudinal analyses are not required in the lateral analysis.

$$\Delta F_y = \Delta T_F \cos \alpha_{2_F} + \Delta T_R \cos \alpha_{2_R}$$

$$\Delta L = \sum y F_z - z F_y + L_p \quad (10.3-15)$$

$$\Delta N = \sum x F_y - y F_x + N_p$$

where

$$L_p = \sum_{n=1}^2 \frac{C_{m_p} N_p}{r_p^2} (\dot{\Delta l}_n - \dot{\Delta l}_{2n}) + \frac{4a_c}{\pi r_p^2} (\Delta l_n - \Delta l_{2n})$$

$$N_p = \sum_{n=1}^2 \frac{C_{m_p} N_p}{r_p^2} (\dot{\Delta l}_n - \dot{\Delta l}_{2n}) + \frac{4a_c}{\pi r_p^2} (\Delta l_n - \Delta l_{2n})$$

Flow diagrams for subroutines FRICT, FRVT, FRHZ are shown in Figures 10.1 through 10.3. Subroutine FRKT contains the logic determining which configuration is to be analyzed while subroutines FRVT and FRHZ calculate the friction effects for vertical and horizontal configurations respectively.

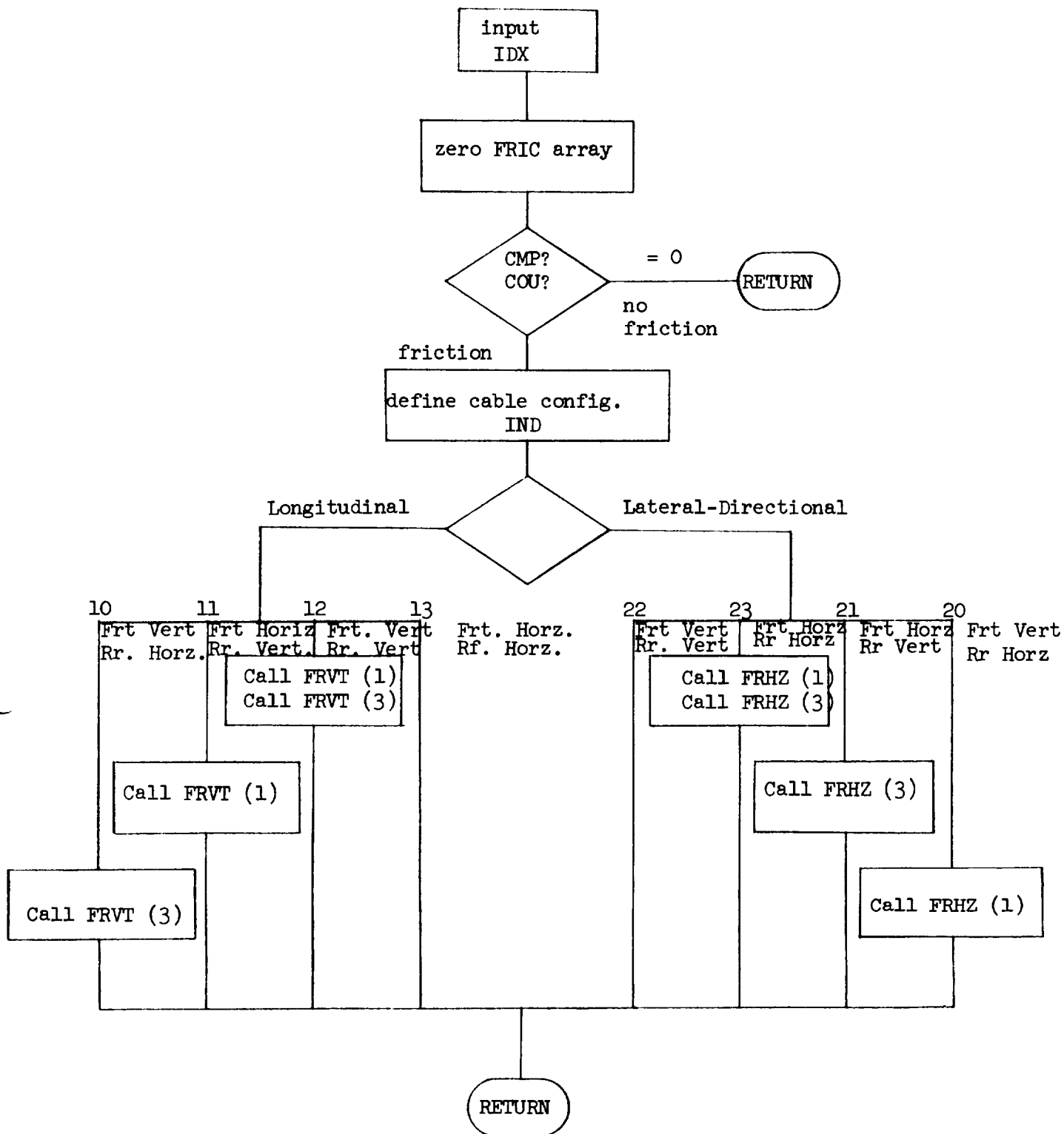


Figure 10.1 - FLOW DIAGRAM - SUBROUTINE FRICT

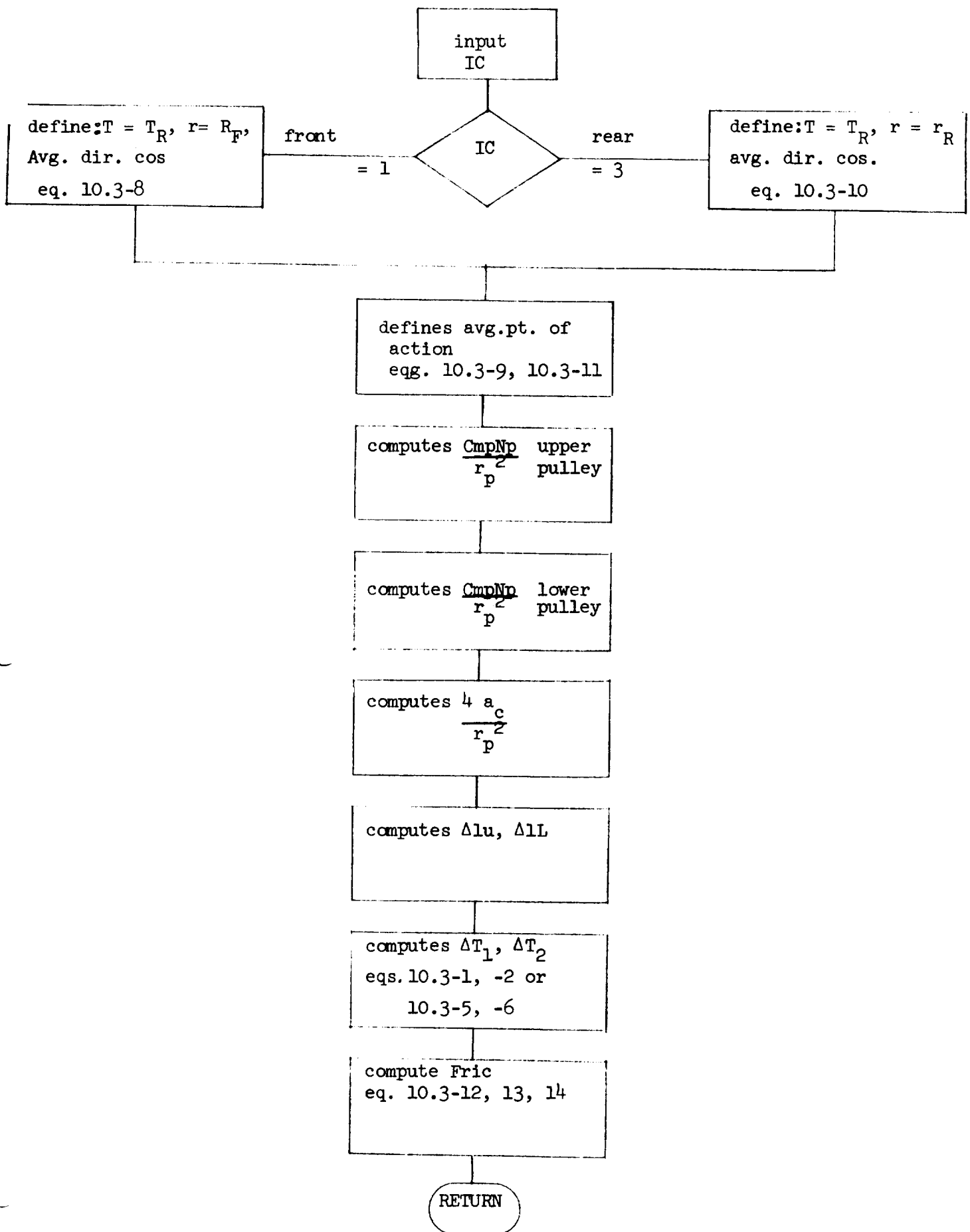


FIGURE 10.2 - FLOW CHART - SUBROUTINE FRVT

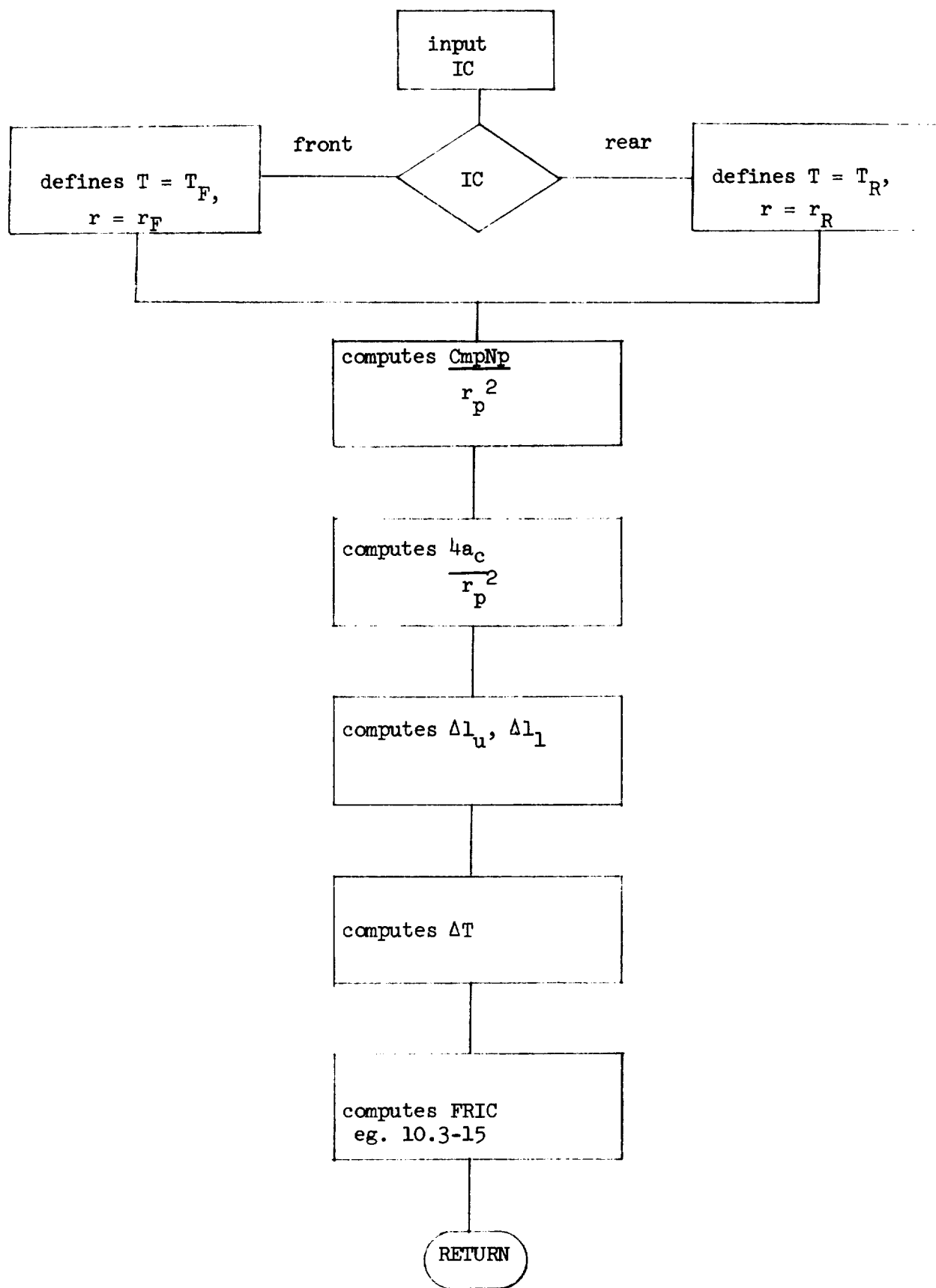


FIGURE 10.3 - FLOW DIAGRAM - SUBROUTINE FRHZ

11.0 INPUT DATA

The format for input data is most easily explained by reproducing the 'READ' statements as they appear in the program.

```
READ (IR, 1) (TITLE (I), I = 1, 20)          (1)
```

```
1 FORMAT (20A4)
```

```
READ (IR, 2) (KODE(I), I = 1, 16)            (2)
```

```
2 FORMAT (15I5)
```

Then either 3A or 3B: The value of KODE (7) will determine which input to use.

```
READ (IR, 3) (AERO (I), I = 1, 36)           (3A)
```

```
CALL TABIN1 (1, 36) (See Appendix A)         (3B)
```

Continuing:

```
READ (IR, 3) (AERO (I), I = 44, 59)          (4)
```

```
READ (IR, 3) (AERO (I), I = 66, 130)         (5)
```

```
3 FORMAT (6 E12.5)
```

If unsnubbed snubber data is to be read in (determined by KODE (12)) the following statement applies.

```
CALL TABIN (1, 2) (See Appendix A)
```

If unsnubbed data is not to be read in computations begin.

After completion of the first run the following 'READ' statements initialize another run.

```
READ (IR, 1) (TITLE (I), I = 1, 20)          (6)
```

```
READ (IR, 2) (KODE (I), I = 1, 16)           (7)
```

```
READ (IR, 3) I, VALUE
```

I = element in the 'AERO' array to be changed.

VALUE = new value of the element

NOTE: If $I > 1$ this 'READ' statement is repeated.
If $I = 0$ the program begins computation.
All succeeding cases follow the same format.

A description of the aforementioned arrays follows.

<u>ARRAY</u>	<u>DESCRIPTION</u>
TITLE	Alpha-numeric array containing title describing the run to be made.
KODE	Array containing various program option parameters.
AERO	Array containing all the input data pertaining to model, mount system and tunnel conditions.

11.1 KODE, AERO Description

A description of each element in the 'KODE' and 'AERO' array follows:

<u>NAME</u>	<u>VALUE</u>	<u>DESCRIPTION</u>
KODE (1)		Run number
KODE (2)	-1	Calculate longitudinal stability only
	0	Calculate lateral/directional stability only
	+1	Calculate both longitudinal and lateral/directional stability
KODE (3)	0	No root locus
	+1	Do root locus
KODE (4)		Element in 'AERO' array to be varied for root locus
KODE (5)	0	Basic printout
	+1	Basic printout plus various test parameters
KODE (6)	+1	Front cable vertical - rear cable horizontal
	+2	Front cable horizontal - rear cable vertical
	+3	Front and rear cable vertical

NAME	VALUE	DESCRIPTION
	+4	Front and rear cable horizontal
KODE (7)	+1	Aero data to be input in table form
	0	Aero data to input at specific mach number
KODE (8)	+4	Longitudinal matrix with no stability augmentation
	+5	Longitudinal matrix with stability augmentation
KODE (9)	+3	Lateral/directional matrix, no stability augmentation
	+4	Lateral/directional matrix, with yaw stability augmentation
	+5	Lateral/directional matrix, with roll and yaw stability augmentation
KODE (10)	0	No snubber
	+1	Analyze snubber in unsnubbed condition
	+2	Analyze snubber in snubbed condition
KODE (11)	0	No anti-lift cable
	+1	Anti-lift cable in
KODE (12)	0	No unsnubbed snubber data input
	+1	Unsnubbed snubber data will be read in

	UNITS	LABEL	DESCRIPTION	
AERO (1)	1/ft./sec.	CDU	$\partial C_D / \partial (u/V_o)$	$\begin{bmatrix} C_{D_u} \end{bmatrix}$
AERO (2)	1/ft./sec.	CLU	$\partial C_D / \partial (u/V_o)$	$\begin{bmatrix} C_{L_u} \end{bmatrix}$
AERO (3)	1/ft./sec.	CMU	$\partial C_m / \partial (u/V_o)$	$\begin{bmatrix} C_{m_u} \end{bmatrix}$
AERO (4)	1/rad	CDA	$\partial C_D / \partial (\alpha)$	$\begin{bmatrix} C_{D_\alpha} \end{bmatrix}$
AERO (5)	1/rad	CLA	$\partial C_L / \partial (\alpha)$	$\begin{bmatrix} C_{L_\alpha} \end{bmatrix}$
AERO (6)	1/rad	CMA	$\partial C_m / \partial (\alpha)$	$\begin{bmatrix} C_{m_\alpha} \end{bmatrix}$
AERO (7)	1/rad/sec	CDQ	$\partial C_D / \partial (q\bar{C}/2V_o)$	$\begin{bmatrix} C_{D_q} \end{bmatrix}$
AERO (8)	1/rad/sec	CLQ	$\partial C_L / \partial (q\bar{C}/2V_o)$	$\begin{bmatrix} C_{L_q} \end{bmatrix}$
AERO (9)	1/rad/sec	CMQ	$\partial C_m / \partial (q\bar{C}/2V_o)$	$\begin{bmatrix} C_{m_q} \end{bmatrix}$
AERO (10)	N.D.	CDO	Drag coefficient at $\alpha = 0$	$\begin{bmatrix} C_{D_o} \end{bmatrix}$
AERO (11)	N.D.	CLO	Lift coefficient at $\alpha = 0$	$\begin{bmatrix} C_{L_o} \end{bmatrix}$
AERO (12)	N.D.	CMO	Pitching moment at $\alpha = 0$	$\begin{bmatrix} C_{m_o} \end{bmatrix}$
AERO (13)	1/rad	CDDE	$\partial C_D / \partial (\delta_e)$	$\begin{bmatrix} C_{D_{\delta_e}} \end{bmatrix}$
AERO (14)	1/rad	CLDE	$\partial C_L / \partial (\delta_e)$	$\begin{bmatrix} C_{L_{\delta_e}} \end{bmatrix}$
AERO (15)	1/rad	CMDE	$\partial C_m / \partial (\delta_e)$	$\begin{bmatrix} C_{m_{\delta_e}} \end{bmatrix}$
AERO (16)	1/rad/sec	CDAD	$\partial C_D / \partial (\dot{\alpha}\bar{C}/2V_o)$	$\begin{bmatrix} C_{D_{\dot{\alpha}}} \end{bmatrix}$
AERO (17)	1/rad/sec	CLAD	$\partial C_L / \partial (\dot{\alpha}\bar{C}/2V_o)$	$\begin{bmatrix} C_{L_{\dot{\alpha}}} \end{bmatrix}$
AERO (18)	1/rad/sec	CMAD	$\partial C_m / \partial (\dot{\alpha}\bar{C}/2V_o)$	$\begin{bmatrix} C_{m_{\dot{\alpha}}} \end{bmatrix}$
AERO (19)	1/rad/sec	CYB	$\partial C_y / \partial (\beta)$	$\begin{bmatrix} C_{y_\beta} \end{bmatrix}$
AERO (20)	1/rad	CLB	$\partial C_\ell / \partial (\beta)$	$\begin{bmatrix} C_{\ell_\beta} \end{bmatrix}$
AERO (21)	1/rad	CNB	$\partial C_n / \partial (\beta)$	$\begin{bmatrix} C_{n_\beta} \end{bmatrix}$
AERO (22)	1/rad/sec	CYP	$\partial C_y / \partial (pb/2V_o)$	$\begin{bmatrix} C_{y_p} \end{bmatrix}$
AERO (23)	1/rad/sec	CLP	$\partial C_\ell / \partial (pb/2V_o)$	$\begin{bmatrix} C_{\ell_p} \end{bmatrix}$
AERO (24)	1/rad/sec	CNP	$\partial C_n / \partial (pb/2V_o)$	$\begin{bmatrix} C_{n_p} \end{bmatrix}$
AERO (25)	1/rad/sec	CYR	$\partial C_y / \partial (rb/2V_o)$	$\begin{bmatrix} C_{y_r} \end{bmatrix}$
AERO (26)	1/rad/sec	CLR	$\partial C_\ell / \partial (rb/2V_o)$	$\begin{bmatrix} C_{\ell_r} \end{bmatrix}$

	UNITS	LABEL	DESCRIPTION	
AERO (27)	1/rad/sec	CNR	$\partial C_n / \partial (rb/2V_o)$	$\begin{bmatrix} C_{n_r} \end{bmatrix}$
AERO (28)	1/rad	CYDR	$\partial C_y / \partial (\delta_r)$	$\begin{bmatrix} C_{y \delta_r} \end{bmatrix}$
AERO (29)	1/rad	CLDR	$\partial C_\ell / \partial (\delta_r)$	$\begin{bmatrix} C_{\ell \delta_r} \end{bmatrix}$
AERO (30)	1/rad	CNDR	$\partial C_n / \partial (\delta_r)$	$\begin{bmatrix} C_{n \delta_r} \end{bmatrix}$
AERO (31)	1/rad	CYDA	$\partial C_y / \partial (\delta_a)$	$\begin{bmatrix} C_{y \delta_a} \end{bmatrix}$
AERO (32)	1/rad	CLDA	$\partial C_\ell / \partial (\delta_a)$	$\begin{bmatrix} C_{\ell \delta_a} \end{bmatrix}$
AERO (33)	1/rad	CNDA	$\partial C_n / \partial (\delta_a)$	$\begin{bmatrix} C_{n \delta_a} \end{bmatrix}$
AERO (34)	1/rad	CYDS	$\partial C_y / \partial (\delta_s)$	$\begin{bmatrix} C_{y \delta_s} \end{bmatrix}$
AERO (35)	1/rad	CLDS	$\partial C_\ell / \partial (\delta_s)$	$\begin{bmatrix} C_{\ell \delta_s} \end{bmatrix}$
AERO (36)	1/rad	CNDS	$\partial C_n / \partial (\delta_s)$	$\begin{bmatrix} C_{n \delta_s} \end{bmatrix}$
AERO (44)	in.	XREF*	Distance from aerodynamic ref. center to the equation ref. center along the X body axis	
AERO (45)	in.	ZREF	Distance from aerodynamic ref. center to the equation ref. center along the Z body axis	
AERO (46)	in.	XCG	Distance from model mass & inertia ref. center to the equation ref. center along the X body axis	
AERO (47)	in.	ZCG	Distance from model mass & inertia ref. center to the equation ref. center along the Z body axis	
AERO (48)		AMACH	Tunnel mach number	
AERO (49)	ft/sec	VO	Tunnel velocity	
AERO (50)	slugs	AM	Model mass	
AERO (51)	slug/ft ³	RHO	Tunnel density	

	UNITS	LABEL	DESCRIPTION
AERO (52)	lbs	WT	Model weight
AERO (53)	ft	B	Model reference span
AERO (54)	ft	CBAR	Model reference chord
AERO (55)	ft ²	SW	Model reference wing area
AERO (56)	slug/ft ²	XIXZ	Model cross product of inertia (I _{XZ})
AERO (57)	slug/ft ²	XIXX	Model roll inertia (I _{xx}), body axis at C.G.
AERO (58)	slug/ft ²	YIYY	Model pitch inertia (I _{yy}), body axis at C.G.
AERO (59)	slug/ft ²	ZIZZ	Model yaw inertia (I _{zz}), body axis at C.G.
AERO (66)	in.	WLUF	Water line-upper front cable tie-down point (fr. vert.)
AERO (67)	in.	WLLF	Water line-lower front cable tie-down point (fr. vert.)
AERO (68)	in.	WLUR	Water line-upper rear cable tie-down point (rr. vert.)
AERO (69)	in.	WLLR	Water line-lower rear cable tie-down point (rr. vert.)
AERO (70)	in.	WLHF	Water line-horizontal front cable tie-down point (fr. hor.)
AERO (71)	in.	WLHR	Water line-horizontal rear cable tie-down point (rr. hor.)
AERO (72)	in.	STAF	Station-front cable tie-down point (fr. vert. or hor.)
AERO (73)	in	STAR	Station-rear cable tie-down point (rr. vert. or hor.)
AERO (74)	in	BLHF	Butt line-horizontal front cable tie-down point (fr. hor.)

	UNITS	LABEL	DESCRIPTION
AERO (75)	in.	BLHR	Butt line-horizontal rear cable tie-down point (rr. hor.)
AERO (76)	in.	WLCR	Water line-equation reference point
AERO (77)	in.	STACR	Station - equation reference point
AERO (78)	in.	BLCR	Butt line-equation reference point
AERO (79)	in.	EF**	Distance along X body axis from ref. center to vertical front pulley
AERO (80)	in.	ER	Distance along X body axis from ref. center to vertical rear pulley
AERO (81)	in.	AF	Distance along X body axis from ref. center to horizontal front pulley
AERO (82)	in.	AR	Distance along X body axis from ref. center to horizontal rear pulley
AERO (83)	in.	HUCF	Distance along Z body axis from ref. center to upper front pulley
AERO (84)	in.	HLCF	Distance along Z body axis from ref. center to lower front pulley
AERO (85)	in.	HUCR	Distance along Z body axis from ref. center to upper rear pulley
AERO (86)	in.	HLCR	Distance along Z body axis from ref. center to lower rear pulley
AERO (87)	in.	DCF	Distance along Y body axis from ref. center to horizontal front pulley
AERO (88)	in.	DCR	Distance along Y body axis from ref. center to horizontal rear pulley

UNITS		LABEL	DESCRIPTION
AERO (89)		blank	
AERO (90)	in	RVF	Radius of vertical front pulley
AERO (91)	in	RHF	Radius of horizontal front pulley
AERO (92)	in	RVR	Radius of vertical rear pulley
AERO (93)	in	RHR	Radius of horizontal rear pulley
AERO (94)	lbs	TRO	Rear cable tension
AERO (95)	lbs/in	AKR	Rear cable spring constant
AERO (96)	ft-#/rad	COU	Pulley Coulomb friction (a_c)
AERO (97)	in	STLTT	Station - lift cable tie-down point
AERO (98)	in	WLLTT	Water line - lift cable tie-down point
AERO (99)	lbs	TLFTO	Lift cable tension
AERO (100)	lbs/in	AKLFT	Lift cable spring constant
AERO (101)		blank	
AERO (102)	in	ALT _X *	Distance along X body axis from lift cable attachment point to the equation reference center
AERO (103)	in	ALT _Z	Distance along Z body axis from lift cable attachment point to the equation reference center
AERO (104)	ft-#/RPS	CMP	Pulley rolling friction coefficient
AERO (105)	in	SNUX***	Distance along X body axis from model upper attachment point to the equation reference center
AERO (106)	in	SNUY	Distance along Y body axis from model upper snubber attachment point to the equation reference center
AERO (107)	in	SNUZ	Distance along Z body axis from model upper snubber attachment point to the equation reference center

	UNITS	LABEL	DESCRIPTION
AERO (108)	in	SNLX	Distance along X body axis from model lower snubber attachment point to the equation reference center
AERO (109)	in	SNLY	Distance along Y body axis from model lower snubber attachment point to the equation reference center
AERO (110)	in	SNLZ	Distance along Z body axis from model lower snubber attachment point to the equation reference center
AERO (111)	in	SNUST	Station - upper snubber tie-down point
AERO (112)	in	SNUWL	Water line - upper snubber tie-down point
AERO (113)	in	SNUBL	Butt line - upper snubber tie-down point
AERO (114)	in	SNLST	Station - lower snubber tie-down point
AERO (115)	in	SNLWL	Water line - lower snubber tie-down point
AERO (116)	in	SNLBL	Butt line - lower snubber tie-down point
AERO (117)	lbs	TUSNO	Upper snubber, snubbed tension
AERO (118)	lbs	TLSNO	Lower snubber, snubbed tension
AERO (119)	lbs/in	AKSNU	Upper snubber, snubbed spring constant
AERO (120)	lbs/in	AKSNL	Lower snubber, snubbed spring constant
AERO (121)	lbs/in/sec	ADSNU	Upper snubber, snubbed damping constant

	UNITS	LABEL	DESCRIPTION
AERO (122)	lbs/in/sec	ADSNL	Lower snubber, snubbed damping constant
AERO (123)	rad/rad/sec	AKSY	Feedback gain - yaw rate to rudder
AERO (124)	rad/rad/sec	AKPHI	Feedback gain - roll rate to aileron
AERO (125)	rad/rad/sec	AKTHE	Feedback gain - pitch rate to elevator
AERO (126)	blank		
AERO (127)	sec.	T1SY	Time constant for lag on yaw rate feedback
AERO (128)	sec.	T2PHI	Time constant for lag on roll rate feedback
AERO (129)	sec.	T3THE	Time constant for lag on pitch rate feedback
AERO (130)	blank		

* See Figure 11.1 for pictorial representation of various reference centers

** See Figure 11.2 for pictorial representation of pulley geometry

*** See Figure 11.3 for pictorial representation of snubber cable geometry

11.2 TABLE INPUT

If the aero data and snubber data are to be read in table format, the following discussion applies.

The first 36 tables contain the aero derivatives in stability axis vs. mach number. The order is the same as AERO (1) through AERO (36). The units for each derivative are also the same as AERO (1) through AERO (36). The table input format is shown in Appendix A. This data is read in under TABIN1.

The unsnubbed snubber data is contained in Tables 1 and 2. Table 1 contains cable tension (lbs) vs. dynamic pressure (psf) and linear distance (in) between model tie-down point and tunnel side wall. Table 2 contains cable angle (rad) vs. dynamic pressure (psf) and linear distance (in) between model tie-down point and tunnel side wall. The tensions and angles mentioned here are described in detail in section 8.0. The table input format is shown in Appendix A. This data is read in under TABIN.

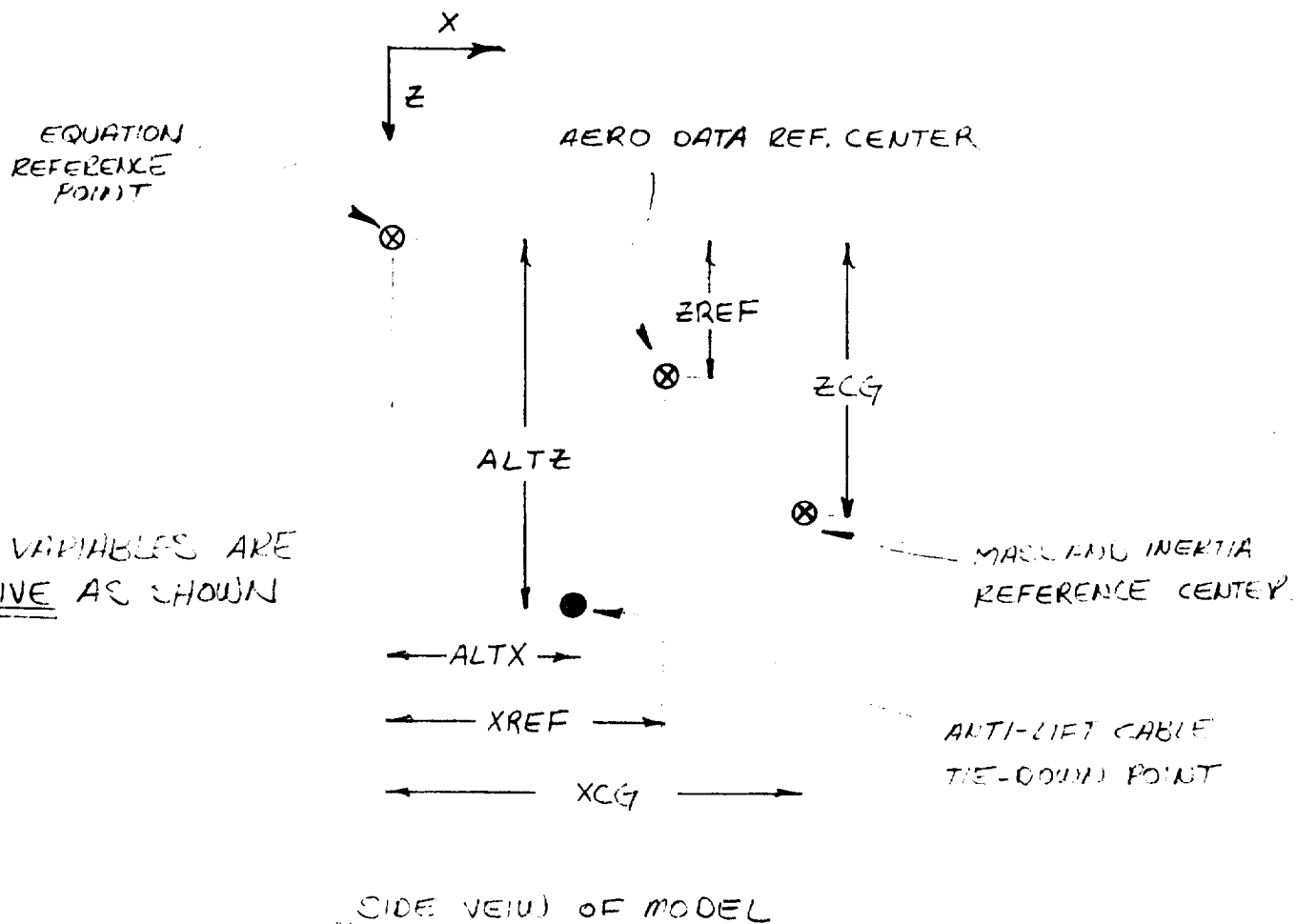
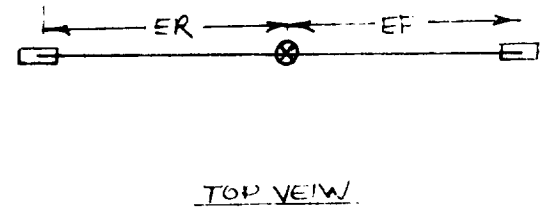
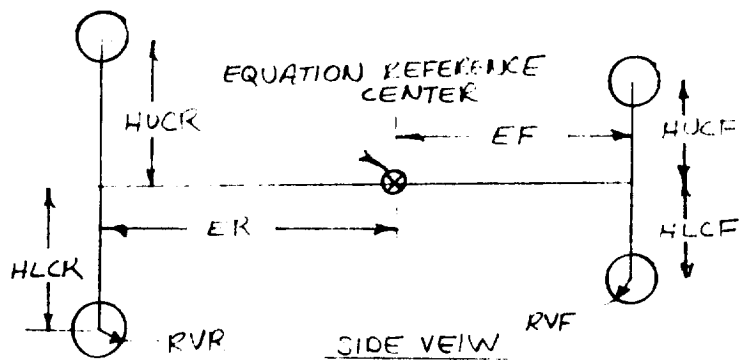
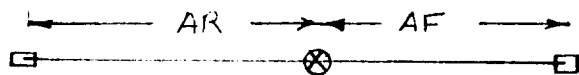


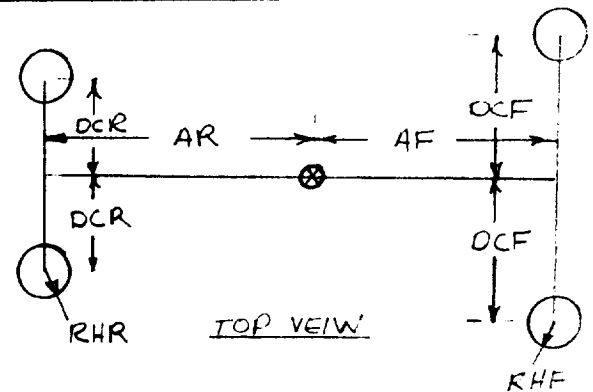
FIG. 11.1 - REFERENCE CENTER AND LIFT CABLE INPUT DATA.



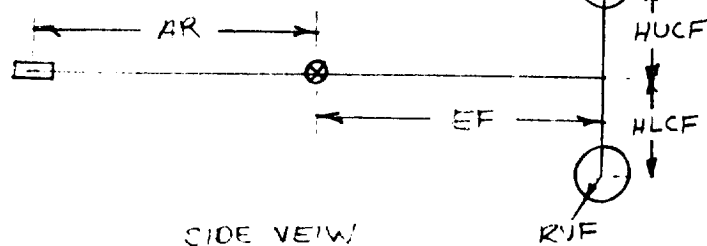
FRONT VERTICAL - REAR VERTICAL



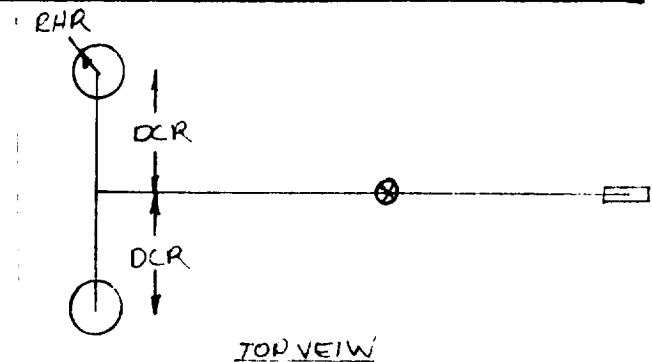
SIDE VIEW



FRONT HORIZONTAL - REAR HORIZONTAL

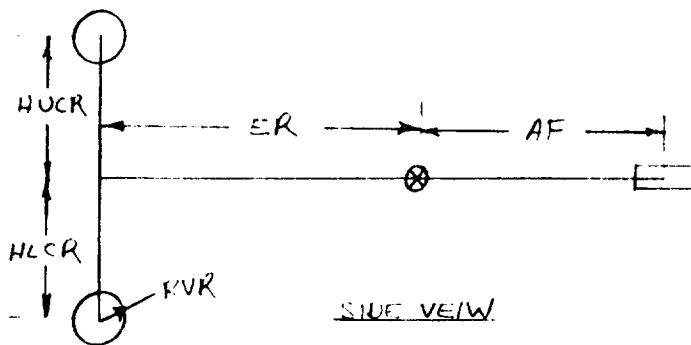


SIDE VIEW

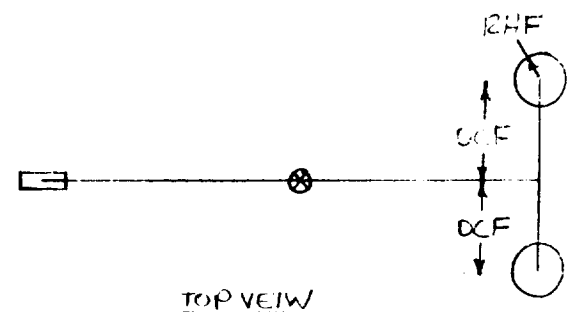


TOP VIEW

FRONT VERTICAL - REAR HORIZONTAL



SIDE VIEW



TOP VIEW

FRONT HORIZONTAL - REAR VERTICAL

FIG. 11.2 - PULLEY GEOMETRY

REFERENCES

- 1) Reed, Abbott - A New 'Free Flight' Mount System For High Speed Wind Tunnel Flutter Models - NASA - Langley Research Center - 9/63
- 2) Bennett - Comments on Mount System Damping Based on Pulley Rolling Friction
- 3) Thelander Aircraft Motion Analysis - FOL-TOR-64-70
- 4) Methods of Analysis and Synthesis of Piloted Aircraft Flight Control Systems - BU AER Report AE-61-41-3/52
- 5) Dynamics of the Airframe - BU AER Report AE-61-42-9/52
- 6) Hildebrand - Advanced Calculus for Engineers

APPENDIX A

A-1

TABIN, TABIN1

If data is to be input in table form, subroutine TABIN is used. When reading aero data the first independent variable is mach number. When reading unsnubbed snubber data the first independent variable is dynamic pressure (psf) and the second independent variable is length (L_s) in inches.

- Restrictions:
1. The tabular values for the independent variables must be in algebraically increasing order.
 2. The independent variables and functional values of the table must:
 - a) Be single precision numbers less than 99999E9.
 - b) Have a maximum of 7 significant figures if positive.
 - c) Have a maximum of 6 significant figures if negative.

A maximum of 99 cards is allowed for each table.

Usage:

- A. Tables are prepared according to the form on the following page. Variable noted there are:

K = table number - any positive fixed point number.

L1 = Number of tabular values of the first independent variable (x).

L2 = Number of tabular values of the second independent variable (y).

Seq. no. = sequence number of card within a table beginning with 0 for the first card, 1 for the second, etc.

Z = Value of the third independent variable (z).
A separate table is needed for each tabular value of Z.

$F(i,j)$ = functional value for x_i , y_j , and Z.

The last card for every set of tables read in MUST BE BLANK.

CARD FORMAT FOR EACH TABLE

	K	L1	L2		Seq. No.
Column	9-12	13-14	15-16		71-72

Z	x ₁	x ₂	x ₃	x ₄	x ₅	x ₆	x ₇	x ₈	x ₉	Seq. No.
---	----------------	----------------	----------------	----------------	----------------	----------------	----------------	----------------	----------------	-------------

y ₁	f(1,1)	f(2,1)	f(3,1)	f(4,1)	f(5,1)	f(6,1)	f(7,1)	f(8,1)	f(9,1)	Seq. No.
----------------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------------

⋮

y _{L2}	f(1, L2)	f(2, L2)	f(3, L2)	f(4, L2)	f(5, L2)	f(6, L2)	f(7, L2)	f(8, L2)	f(9, L2)	Seq. No.
-----------------	----------	----------	----------	----------	----------	----------	----------	----------	----------	-------------

Z	x ₁₀	x ₁₁	x ₁₂	x ₁₃	x ₁₄	x ₁₅	x ₁₆	x ₁₇	x ₁₈	Seq. No.
---	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-------------

y	f(10, 1)	f(11, 1)	f(12, 1)	f(13, 1)	f(14, 1)	f(15, 1)	f(16, 1)	f(17, 1)	f(18, 1)	Seq. No.
---	----------	----------	----------	----------	----------	----------	----------	----------	----------	-------------

y _{L2}	f(10, L2)	f(11, L2)	f(13, L2)	f(13, L2)	f(14, L2)	f(15, L2)	f(16, L2)	f(17, L2)	f(18, L2)	Seq. No.
-----------------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-------------

Col. 1-7 8-14 15-21 22-28 29-35 36-42 43-49 50-56 57-63 64-70 71-72

Additional x values are similarly handled.

BLANK CARD - last in set of data read in at one time.

For first 9 x-values

For second 9 x-values

B. Calling sequence:

CALL TABIN (NUMTBL, IZ, NG)

NUMTBL = Number of the first table to be read in.
= 1 for the first set of tables read in
on a job.

IZ = Maximum number of tables in storage at
one time.

NG = error return - set equal to:
0 - tables are read in successfully
1 - error in loading tables.

C. COMMON statement to be made in the calling program:

COMMON ZZZ(n)

where ZZZ is a dummy name, n is computed as follows:

$$n = 3IZ + \sum_{i=1}^{IZ} (L1_i + 1) (L2_i + 1)$$

ZZZ must be the first array stored in blank COMMON.

A-2

STINT, STINT1

Subroutine STINT is a linear interpolation routine used to
gather data from the tables.

Purpose: To look up in a table and interpolate functions of
1, 2, or 3 variables.

Restrictions: 1. CALL TABIN to read in tables (see TABIN write-up).
2. Extrapolation is not performed for arguments off
the tables.

Method:*

x = ARG1	$x_0 < x < x_1$	x_0, x_1 - consecutive tabular values
y = ARG2	$y_0 < y < y_1$	y_0, y_1 - consecutive tabular values
z = ARG3	$z_0 < z < z_1$	z_0, z_1 - tabular values for consecutive tables
f(i,j)	functional value at (x_i, y_i)	

$$A = \frac{(y_1 - y) \left[(x_1 - x) f(0,0) - (x_0 - x) f(1,0) \right]}{(y_1 - y_0) (x_1 - x_0)} - \frac{(y_0 - y) \left[(x_1 - x) f(0,1) - (x_0 - x) f(1,1) \right]}{(y_1 - y_0) (x_1 - x_0)}$$

Single table interpolation

$$FCT = f(1,0) - \frac{x_1 - x}{x_1 - x_0} (f(1,0) - f(0,0))$$

Double table interpolation

$$FCT = A$$

Triple table interpolation

A is found for the z_0 table (A_0) and the z_1 table (A_1).

$$FCT = A_1 - \frac{z_1 - z}{z_1 - z_0} (A_1 - A_0)$$

Usage: CALL STINT (ARG1, ARG2, ARG3, MINTBL, MAXTBL, FCT, NG)

ARG1 = floating point value used as search argument 1

ARG2 = floating point value used as search argument 2

ARG3 = floating point value used as search argument 3

MINTBL = lower bound of table position number.

MAXTBL = upper bound of table position number.

FCT = floating point variable which is returned
 with the result of the interpolation.

NG = Error indicator

 = 1 - error in loading tables (set by TABIN)

 = 2 - error in calling sequence or machine error

 = 3 - argument not in domain of table

 = 4 - argument(s) are within tables but function
 is discontinuous or non-existent.

If there is no error, the last value of NG remains in storage. NG should be interrogated after each return from STINT. If $NG \neq 0$, set NG to 0 after taking appropriate error control action and before calling STINT again.

For single table interpolation set ARG2 = 0, and ARG3 = 0

For double table interpolation set ARG3 = 0.

For triple table interpolation

Normally at least 2 tables are needed. The tables must have consecutive position numbers. If ARG3 is exactly equal to the tabular value of z (third independent variable), only one table is needed.

A-3

MASH

Subroutine MASH is used to reduce large matrices to smaller ones. It only reduces terms of the same order.

A-4

MATRIX, PRBML, PQFBL

Subroutines MATRIX, PRBML, and PQFBL are used to obtain the eigenvalues of the polynomial matrices defined in subroutines LONG and LAT. Subroutine MATRIX takes the polynomial matrix and derives the characteristic polynomial for that matrix. The roots of the characteristic polynomial are then established in subroutines PRBML and PQFBL. PRBML and PQFBL are called from MATRIX. The dimension statements for this routine are presently set up for a 7 x 7 matrix. If in the future this is to be changed the following definitions will be necessary.

Call MATRIX (A, N, ROOTS, K4A, IER)

A: Input matrix, Dimension = (N, N, 3) the first index refers to the row, second to the column, and third to the polynomial coefficient with $A(i, j, 1)$ = constant term, $A(i, j, 2)$ = linear term, etc.

N: The actual size of the input matrix.

ROOTS: A complex array. Dimension = 29
K4A: Equals the number of roots generated.
IER: Contains error code message. See listing
of PQFBI and PRBBI for description.

The routine is limited to second order polynomials. That is, each polynomials represented in the A array can be no greater than second order.

APPENDIX B

A sample listing of input data is included as an example. The set of input cards listed below is the set provided with the accompanying deck.

Referring to the listing, Case 1 is one in which a root locus is done with the rear cable tension being the parameter varied. Both longitudinal and lateral stability calculations are made. The cable configuration is front vertical rear horizontal with no snubber effects. Case 2 is the same variation in rear cable tension with the unsnubbed snubber effects included. Case 3 is one in which the values for $C_{L\alpha}$ and $C_{m\alpha}$ are changed and only longitudinal stability effects are calculated. In Case 4, $C_{L\alpha}$ and $C_{m\alpha}$ are put back to their original values and the front pulleys are changed to the horizontal configuration. The output corresponding to this input data is contained in APPENDIX C.

FILED CABLE

DATA

P1

GRUMMAN DATA SYSTEM

EST DATA LRC

1	1	1	94	0	1	0	4	3	0	0	1
0.	0.	0.	0.	0.	0.	0.	6.26				-0.81
0.	0.	0.	-8.	0.018			.105				.035
0.	.96		-1.5	0.			0.				0.
-0.73	-0.035		.111	0.			-0.19				-0.01
0.	.050		-0.092								
0.							.8				430.
4.35	.00039		140.	9.16			1.4				11.5
-0.11	1.8		14.	14.							
59.	-59.										
10.	285.			80.							175.
	26.4						8.				8.4
8.4							.92				
.88				.88			140.				3.
	177.		-0.96								
-2.	3.		.05	2.			3.				2.
2.	3.		2.	180.			96.				72.
180.	-96.		72.	80.			80.				50.
50.	0.		0.								

1 4 3				
0	0	20.	100.	200.
0	0	20.	60.	80.
00.	0	25.	65.	85.
00.	0	30.	70.	90.

2 4 3				
0	0	30.	100.	200.
0	1.57	1.20	1.00	.60
100.	1.57	1.10	.90	.40
200.	1.57	1.00	.80	.20

1
2
3
4

1
2
3
4

BLANK CARD

TEST DATA UNSNURRED SNUBBER

2	1	1	94	0	1	0	4	3	1	0	0
---	---	---	----	---	---	---	---	---	---	---	---

BLANK CARD

TEST DATA CHANGE CL AND CM ALPHA

3	-1	0	0	0	1	0	4	3	0	0	0
---	----	---	---	---	---	---	---	---	---	---	---

5 5.5

6 -1.3

BLANK CARD

TEST DATA FRONT PULLEY HORIZONTAL

4	1	0	0	0	4	0	4	3	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

5 6.2

6 -0.8

70 0

74 80.

81 26.4

87 8.4

91 .88

BLANK CARD

APPENDIX C

Contained in this Appendix is the program output
corresponding to the input list shown in Appendix B.

CASE NC=

TEST DATA IRC

PERCT CABLE VERTICAL, BIAF CABLE HORIZONTAL

NO SNUBBERS

KC LIFT/ANTI-LIFT CABLE

INPUT DATA AS SPECIFIED IN AERC ARRAY

AERO(1) = 0.0	AERO(2) = 0.0	AERO(3) = 0.0	AERO(4) = 0.0	AERO(5) = 6.26
AERO(6) = -0.81C	AERO(7) = 0.0	AERO(8) = 0.0	AERO(9) = -8.00	AERO(10) = 0.180E-01
AERO(11) = 0.10E	AERO(12) = 0.350E-01	AERO(13) = 0.0	AERO(14) = 0.960	AERO(15) = -1.50
AERO(16) = 0.0	AERO(17) = 0.0	AERO(18) = 0.0	AERO(19) = -0.730	AERO(20) = -0.350E-01
AERO(21) = 0.111	AERO(22) = 0.0	AERO(23) = -0.190	AERO(24) = -0.100E-01	AERO(25) = 0.0
AERO(26) = 0.500E-01	AERO(27) = -0.920E-01	AERO(28) = 0.0	AERO(29) = 0.0	AERO(30) = 0.0
AERO(31) = 0.0	AERO(32) = 0.0	AERO(33) = 0.0	AERO(34) = 0.0	AERO(35) = 0.0
AERO(36) = 0.0	AERO(37) = 0.0	AERO(38) = 0.0	AERO(39) = 0.0	AERO(40) = 0.0
AERO(41) = 0.0	AERO(42) = 0.0	AERO(43) = 0.0	AERO(44) = 0.0	AERO(45) = 0.0
AERO(46) = 0.0	AERO(47) = 0.0	AERO(48) = 0.0	AERO(49) = 4.35	AERO(50) = 0.0
AERO(51) = 0.390E-03	AERO(52) = 140.	AERO(53) = 9.16	AERO(54) = 1.40	AERO(55) = 11.5
AERO(56) = -0.110	AERO(57) = 1.80	AERO(58) = 14.0	AERO(59) = 0.0	AERO(60) = 0.0
AERO(61) = 0.0	AERO(62) = 0.0	AERO(63) = 0.0	AERO(64) = 0.0	AERO(65) = 0.0
AERO(66) = 59.0	AERO(67) = -59.0	AERO(68) = 0.0	AERO(69) = 0.0	AERO(70) = 0.0
AERO(71) = 0.0	AERO(72) = 10.0	AERO(73) = 285.	AERO(74) = 0.0	AERO(75) = 80.0
AERO(76) = 0.0	AERO(77) = 175.	AERO(78) = 0.0	AERO(79) = 26.4	AERO(80) = 0.0
AERO(81) = 0.0	AERO(82) = 8.00	AERO(83) = 8.40	AERO(84) = 8.40	AERO(85) = 0.0
AERO(86) = 0.0	AERO(87) = 0.0	AERO(88) = 0.920	AERO(89) = 0.0	AERO(90) = 0.880
AERO(91) = 0.0	AERO(92) = 0.0	AERO(93) = 0.880	AERO(94) = 140.	AERO(95) = 3.00
AERO(96) = 0.0	AERO(97) = 177.	AERO(98) = -0.960	AERO(99) = 0.0	AERO(100) = 0.0
AERO(101) = 0.0	AERO(102) = -2.00	AERO(103) = 3.00	AERO(104) = 0.500E-01	AERO(105) = 2.00
AERO(106) = 3.00	AERO(107) = 2.00	AERO(108) = 2.00	AERO(109) = 3.00	AERO(110) = 2.00
AERO(111) = 180.	AERO(112) = 96.0	AERO(113) = 72.0	AERO(114) = 180.	AERO(115) = -96.0
AERO(116) = 72.0	AERO(117) = 80.0	AERO(118) = 80.0	AERO(119) = 50.0	AERO(120) = 50.0
AERO(121) = 5.00	AERO(122) = 5.00	AERO(123) = 0.0	AERO(124) = 0.0	AERO(125) = 0.0
AERO(126) = 0.0	AERO(127) = 0.0	AERO(128) = 0.0	AERO(129) = 0.0	AERO(130) = 0.0

>>>> FOOT LOCUS VARYING AERO (54)

AERO (54) = 84.000

FF. ATT., DEFLIN., & CABLE TENSION

THEA = 2.20 DEG

DELTA = -0.35 DEG

FPT CAP. TENSION = 0.740171E 02 LBS

FF CAP. TENSION = 0.840300E 02 LBS

>>> LONGITUDINAL STABILITY <<<

REAL IMAGINARY 1 H/D-SEC

-8.117E-01 +4.522E 00 1.682E 00 5.930E-01 7.197E-01 7.227E-01 9.052E-02 8.235E-01 5.648E-01

-7.635E-01 +7.306E 00 9.077E-01 1.101E 00 1.162E 00 1.169E 00 1.039E-01 9.473E-01 5.185E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL IMAGINARY 1 H/D-SEC

-8.026E-01 +3.220E 00 8.635E-01 1.158E 00 1.950E 00 5.126E-01 5.283E-01 2.418E-01 2.259E 00 2.089E-01

-1.092E-01 +4.023E 00 3.478E-01 2.874E 00 1.561E 00 6.402E-01 7.105E-01 4.438E-01 4.490E 00 4.450E-02

-3.977E-01 +8.150E 00 1.742E 00 5.732E-01 1.298E 00 1.300E 00 4.865E-02 4.415E-01 7.361E-01

AERO (54) = 98.000

FF. ATT., DEFLIN., & CABLE TENSION

THEA = 2.21 DEG

DELTA = -0.50 DEG

FPT CAP. TENSION = 0.956892E 02 LBS

FF CAP. TENSION = 0.950300E 02 LBS

>>> LONGITUDINAL STABILITY <<<

REAL IMAGINARY 1 H/D-SEC

-4.620E-01 +4.735E 00 1.500E 00 6.665E-01 1.325E 00 7.596E-01 9.701E-02 8.835E-01 5.420E-01

-7.123E-01 +7.613E 00 9.730E-01 1.027E 00 8.255E-01 1.216E 00 9.317E-02 8.483E-01 5.554E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL IMAGINARY 1 H/D-SEC

-9.174E-01 +3.256E 00 7.555E-01 1.323E 00 1.929E 00 5.183E-01 5.384E-01 2.711E-01 2.553E 00 1.703E-01

-1.860E-01 +4.597E 00 3.717E-01 2.689E 00 1.366E 00 7.316E-01 7.896E-01 3.758E-01 3.676E 00 7.821E-02

-2.113E-01 +8.451E 00 1.685E 00 5.934E-01 7.395E-01 1.351E 00 4.838E-02 4.390E-01 7.376E-01

AERO (54) = 112.00

FF. ATT., DEFLIN., & CABLE TENSION

THEA = 2.20 DEG

DELTA = -0.61 DEG

FPT CAP. TENSION = 0.922730E 02 LBS

FF CAP. TENSION = 0.112030E 02 LBS

>>> LONGITUDINAL STABILITY <<<

REAL IMAGINARY 1 H/D-SEC

-5.065E-01 +4.926E 00 1.367E 00 7.313E-01 1.275E 00 7.841E-01 1.023E-01 9.327E-01 5.238E-01

-6.672E-01 +7.918E 00 1.039E 00 9.623E-01 7.934E-01 1.260E 00 8.393E-02 7.635E-01 5.890E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL IMAGINARY 1 H/D-SEC

-9.580E-01 +3.302E 00 7.225E-01 1.383E 00 1.902E 00 5.255E-01 5.476E-01 2.788E-01 2.632E 00 1.613E-01

-1.817E 00 +5.117E 00 3.826E-01 2.612E 00 8.145E-01 8.638E-01 3.335E-01 3.207E 00 1.082E-01

-4.238E-01 +8.813E 00 1.635E 00 6.114E-01 7.129E-01 1.402E 00 4.803E-02 4.355E-01 7.392E-01

AERO (54) = 126.00

FF. ATT., DEFLIN., & CABLE TENSION

THEA = 2.26 DEG

DELTA = -0.73 DEG

FPT CAP. TENSION = 0.109046E 03 LBS

EH. ATT., DEFLIN. & CABLE TENSION

THETA = 35 DEG

DELTA = 25 DEG

FPT CAB. TENSION= 0.155741E 03 IES

BB CAE. TENSION = 0.162C3UE C3 IBS

>>> ICNGITUDINAL STABILITY <<<<

REAL IMAGINARY T F/L-SEC

-6.4569E-C1 +5.6679E 00 1.0669E 00

-5.2223E-C1 +9.4059E 00 1.3273E 00

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IPAGINARY T F/L-SEC

-9.769CE-C1 +3.7156E 00 7.0954E-01

-1.7402E 00 +7.093CE CC 2.5831E-C1

-4.7668E-01 +1.0275E 01 1.4541E 00

AEEC(94) = 196.00

PERIOD-SEC

1.1204E 00

6.68C1E-01

1/T H/D

9.3730E-01

7.5341E-C1

DNATF-CPS

8.9253E-01

1.4970E 00

UNDNAT-CPS

8.9850E-01

1.4993E 00

DAMP RATIO

1.15C8E-01

5.5437E-02

DECAY RATIO

1.05C2E 00

5.0329E-01

PERIOD-SEC

1.6910E 00

8.8583E-01

1/T H/D

1.4054E C0

2.5106E C0

DNATF-CPS

5.5136E-01

1.1289E 00

UNDNAT-CPS

6.1146E-01

1.1624E 00

DAMP RATIO

2.5428E-01

2.3828E-01

DECAY RATIO

2.3833E 00

2.224CE 00

PERIOD-SEC

1.0951E 00

6.4865E-01

1/T H/D

5.6191E-01

7.2813E-01

DNATF-CPS

9.0985E-01

1.5417E 00

UNDNAT-CPS

9.1602E-01

1.5438E 00

DAMP RATIO

1.1585E-01

5.2C34E-C2

DECAY RATIO

1.0572E 00

4.723CE-01

PERIOD-SEC

1.6503E 00

8.4713E-01

1/T H/D

1.4064E C0

2.5002E C0

DNATF-CPS

6.0597E-01

1.1805E 00

UNDNAT-CPS

6.2551E-01

1.2122E 00

DAMP RATIO

2.48C3E-C1

2.2753E-01

DECAY RATIO

2.32C5E 00

2.1180E 00

PERIOD-SEC

5.9587E-01

7.0124E-C1

1/T H/D

1.4064E C0

2.5002E C0

DNATF-CPS

1.6782E 00

1.6800E 00

UNDNAT-CPS

4.6047E-02

4.1785E-01

DAMP RATIO

2.0015E-01

2.3036E-01

DECAY RATIO

4.7485E-01

7.4715E-01

EH. ATT., DEFLIN. & CABLE TENSION

THETA = 2.38 DEG

DELTA = -1.40 DEG

FPT CAB. TENSION= 0.167414E C2 IBS

BB CAE. TENSION = 0.196035E 03 IES

>>> LONGITUDINAL STABILITY <<<<

REAL IPAGINARY T F/L-SEC

-6.6675E-C1 +5.7168E CC 1.0356E CC

-5.0470E-01 +9.6866E CC 1.3734E CC

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

-9.7482E-01 +3.8074E 00 7.1105E-01

-1.733CE 00 +7.4170E 00 3.9996E-01

-4.8606E-01 +1.0545E C1 1.4260E C0

PERIOD-SEC

1.0951E 00

6.4865E-01

1/T H/D

5.6191E-01

7.2813E-01

DNATF-CPS

9.0985E-01

1.5417E 00

UNDNAT-CPS

9.1602E-01

1.5438E 00

DAMP RATIO

1.1585E-01

5.2C34E-C2

DECAY RATIO

1.0572E 00

4.723CE-01

PERIOD-SEC

1.6503E 00

8.4713E-01

1/T H/D

1.4064E C0

2.5002E C0

DNATF-CPS

6.0597E-01

1.1805E 00

UNDNAT-CPS

6.2551E-01

1.2122E 00

DAMP RATIO

2.48C3E-C1

2.2753E-01

DECAY RATIO

2.32C5E 00

2.1180E 00

PERIOD-SEC

5.9587E-01

7.0124E-C1

1/T H/D

1.4064E C0

2.5002E C0

DNATF-CPS

1.6782E 00

1.6800E 00

UNDNAT-CPS

4.6047E-02

4.1785E-01

DAMP RATIO

2.0015E-01

2.3036E-01

DECAY RATIO

4.7485E-01

7.4715E-01

CASE NO= 2 TEST DATA UNSNUBBED SNUBBED
(PRCT CABLE VERTICAL, HEAF CABLE HORIZONTAL
SNUBBERS UNSNUBBED
AC LIFT/ANTI-LIFT CABLE

DATA CHANGE
C 0.0

>>>> ROOT LOCUS VARYING AERC (54)

AERC (54) = 84.000

FF. ATT., DEFLTN, & CABLE TENSION

THETA = 2.26 DEG

DELTA = -0.68 DEG

FRT CAP. TENSION = 0.108811E 03 LBS

F5 CAE. TENSION = C.800315E C2 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T F/L-SEC T H/D-SEC

-5.055E-01 +5.455E-01 1.3702E 00 7.2508E-01

-6.710E-01 +8.283E-01 1.0329E 00 9.6614E-01

>>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T F/L-SEC T F/E-SEC

-7.771E-01 +4.844E-01 6.9155E-01 1.1211E 00

-1.290E-01 +8.126E-01 5.3710E-01 1.8618E 00

-1.125E-01 +9.451E-01 6.1571E-01 1.6241E 00

AERC (54) = 98.000

FF. ATT., DEFLTN, & CABLE TENSION

THETA = 2.28 DEG

DELTA = -0.90 DEG

FRT CAP. TENSION = C.120405E C3 LBS

F5 CAE. TENSION = 0.980322E 02 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T F/L-SEC T F/E-SEC

-5.471E-01 +5.671E-01 1.2710E 00 7.8065E-01

-6.321E-01 +8.578E-01 1.0565E 00 9.1201E-01

>>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC T F/E-SEC

-6.0141E-01 +4.9230E-01 8.6491E-01 1.1562E 00

-1.2505E-01 +8.4024E-01 5.5430E-01 1.8041E 00

-1.1410E-01 +5.7465E-01 6.0717E-01 1.6470E 00

AERC (54) = 112.00

FF. ATT., DEFLTN, & CABLE TENSION

THETA = 2.30 DEG

DELTA = -0.53 DEG

FRT CAP. TENSION = 0.132159E 03 LBS

F5 CAE. TENSION = C.112033E C3 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC T F/L-SEC

-5.737E-01 +5.740E-01 1.2080E 00 8.2780E-01

-5.990E-01 +8.871E-01 1.1570E 00 8.8428E-01

>>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T F/L-SEC T F/E-SEC

-8.2059E-01 +4.9550E-01 8.4470E-01 1.1839E 00

-1.2159E-01 +9.6700E-01 5.6220E-01 1.7600E 00

-1.1531E-01 +1.0034E-01 6.0112E-01 1.6636E 00

AERC (54) = 126.00

FF. ATT., DEFLTN, & CABLE TENSION

THETA = 2.32 DEG

DELTA = -1.06 DEG

FRT CAP. TENSION = 0.143822E C3 LBS

RR CAP. TENSION = 0.126034E 03 IBS

>>> LONGITUDINAL STABILITY <<<

REAL	IMAGINARY	T F/L-SEC	1/T H/C	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAPE RATIO	DECAY RATIO
-6.0143E-01	+5.8668E-01	1.152E-01	6.6767E-01	1.0721E-01	9.3273E-01	9.3762E-01	1.0209E-01	9.3025E-01
-5.7101E-01	+5.1597E-01	1.2139E-01	8.2379E-01	6.8596E-01	1.4578E-01	1.4606E-01	6.2219E-02	5.6562E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL	IMAGINARY	T H/D-SEC	1/T H/C	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-8.3589E-01	+5.0730E-01	9.2023E-01	1.2059E-01	1.2386E-01	8.0739E-01	8.1827E-01	1.6258E-01	1.4936E-01
-1.1965E-01	+8.3298E-01	5.7931E-01	1.7262E-01	7.0362E-01	1.4212E-01	1.4339E-01	1.3280E-01	1.2146E-01
-1.1613E-01	+1.0213E-01	5.668E-01	1.6754E-01	6.0924E-01	1.6414E-01	1.6518E-01	1.1150E-01	1.0207E-01

AIRC(94) = 142.00

PH. ATT., DEFLIN, & CABLE TENSION

THETA = 2.35 DEG

DELTA = -1.20 DEG

PRT CAP. TENSION = 0.155506E 03 IBS

RR CAP. TENSION = 0.140034E 03 IBS

>>> LONGITUDINAL STABILITY <<<

REAL	IMAGINARY	T H/D-SEC	1/T H/C	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAPE RATIO	DECAY RATIO
-6.2493E-01	+5.8177E-01	1.1093E-01	9.0144E-01	1.0522E-01	9.5043E-01	9.5562E-01	1.0406E-01	9.4846E-01
-5.8716E-01	+5.0432E-01	1.2568E-01	7.8939E-01	6.6536E-01	1.5029E-01	1.5055E-01	5.7846E-02	5.2523E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL	IMAGINARY	T F/L-SEC	1/T H/C	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAPE RATIO	DECAY RATIO
-9.4923E-01	+5.1855E-01	8.1717E-01	1.2237E-01	1.2211E-01	8.1893E-01	8.2998E-01	1.6265E-01	1.4943E-01
-1.1796E-01	+9.1831E-01	5.8811E-01	1.7008E-01	6.8429E-01	1.4614E-01	1.4734E-01	1.2732E-01	1.1635E-01
-1.1670E-01	+1.0586E-01	5.9398E-01	1.6836E-01	5.9354E-01	1.6948E-01	1.6950E-01	1.0957E-01	9.9926E-01

AERO(94) = 154.00

PH. ATT., DEFLIN, & CABLE TENSION

THETA = 2.37 DEG

DELTA = -1.34 DEG

PRT CAP. TENSION = 0.167182E 03 IBS

RR CAP. TENSION = 0.154035E 03 IBS

>>> LONGITUDINAL STABILITY <<<

REAL	IMAGINARY	T F/L-SEC	1/T H/C	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAPE RATIO	DECAY RATIO
-6.4472E-01	+5.6748E-01	1.0751E-01	9.3018E-01	1.0340E-01	9.6709E-01	9.7251E-01	1.0551E-01	9.6180E-01
-5.2641E-01	+5.7210E-01	1.3157E-01	7.6003E-01	6.4633E-01	1.5472E-01	1.5495E-01	5.4113E-02	4.5123E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL	IMAGINARY	T H/D-SEC	1/T H/C	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-8.5623E-01	+5.2169E-01	8.0759E-01	1.2382E-01	1.2044E-01	8.3029E-01	8.4145E-01	1.6234E-01	1.4913E-01
-1.1645E-01	+9.4272E-01	5.9502E-01	1.6806E-01	6.6650E-01	1.5004E-01	1.5118E-01	1.2264E-01	1.1201E-01
-1.1707E-01	+1.0553E-01	5.9208E-01	1.6890E-01	5.7896E-01	1.7272E-01	1.7373E-01	1.0725E-01	9.7764E-01

AIRC(94) = 168.00

PH. ATT., DEFLIN, & CABLE TENSION

THETA = 2.40 DEG

DELTA = -1.49 DEG

PRT CAP. TENSION = 0.178853E 03 IBS

RR CAP. TENSION = 0.160036E 03 IBS

>>> LONGITUDINAL STABILITY <<<

REAL	IMAGINARY	T H/D-SEC	1/T H/C	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-6.5170E-01	+5.0775E-01	1.0475E-01	9.5464E-01	1.0174E-01	9.8853E-01	9.8853E-01	1.0650E-01	9.7124E-01
-5.0935E-01	+9.9939E-01	1.3608E-01	7.3464E-01	6.2870E-01	1.5906E-01	1.5926E-01	5.0902E-02	4.6200E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL	IMAGINARY	T F/L-SEC	1/T H/C	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-8.6656E-01	+5.2673E-01	7.5568E-01	1.2502E-01	1.1884E-01	8.4149E-01	8.5272E-01	1.6174E-01	1.4857E-01
-1.1545E-01	+9.6654E-01	6.0040E-01	1.6456E-01	6.5007E-01	1.5383E-01	1.5492E-01	1.1860E-01	1.0827E-01
-1.1730E-01	+1.1113E-01	5.9293E-01	1.6922E-01	5.6537E-01	1.7687E-01	1.7786E-01	1.0496E-01	9.5675E-01

AIRC(94) = 182.00

EE. ATT. LEFTIN. 6 CABLE TENSION

THETA = 2.42 DEG

DELTA = -1.65 DEG

PRI CAB. TENSION = 0.190527E C3 IBS

RR CAB. TENSION = 0.182037E C3 IBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D 1/T H/D-SEC 1/T H/D-SEC 1/T H/D-SEC 1/T H/D-SEC

-6.7637E-01 +6.2708E 00 1.0250E 00 5.1565E-01 1.0020E 00 9.9803E-01 1.0038E 00 1.0722E-01 9.7758E-01 5.0783E-01

-4.9429E-01 +1.0261E 01 1.4023E 00 7.1311E-01 6.1235E-01 1.6331E 00 1.6350E 00 4.8117E-02 4.3667E-01 7.3684E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D 1/T H/D-SEC 1/T H/D-SEC 1/T H/D-SEC 1/T H/D-SEC

-8.7343E-01 +5.3568E 00 7.9359E-01 1.2601E 00 1.1729E 00 8.5256E-01 8.6382E-01 1.6053E-01 1.4782E 00 3.5898E-01

-1.1466E 00 +9.9972E 00 6.0453E-01 1.6542E 00 6.3484E-01 1.5752E 00 1.5857E 00 1.1508E-01 1.0501E 00 4.8292E-01

-1.1741E 00 +1.1369E 01 5.5036E-01 1.6939E 00 5.5267E-01 1.8094E 00 1.8190E 00 1.0273E-01 9.3616E-01 5.2262E-01

AEPC(94) = 156.00

EE. ATT. LEFTIN. 6 CABLE TENSION

THETA = 2.45 DEG

DELTA = -1.61 DEG

PRI CAB. TENSION = 0.202213E C3 IBS

RR CAB. TENSION = 0.196037E C3 IBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D 1/T H/D-SEC 1/T H/D-SEC 1/T H/D-SEC 1/T H/D-SEC

-6.8855E-01 +6.3623E 00 1.0062E 00 5.9379E-01 9.8756E-01 1.0126E 00 1.0185E 00 1.0764E-01 9.8743E-01 5.0648E-01

-4.8119E-01 +1.0522E 01 1.4405E 00 6.9421E-01 5.9712E-01 1.6747E 00 1.6764E 00 4.5583E-02 4.1453E-01 7.5026E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D 1/T H/D-SEC 1/T H/D-SEC 1/T H/D-SEC 1/T H/D-SEC

-8.7919E-01 +5.4256E 00 7.8839E-01 1.2684E 00 1.1581E 00 8.6351E-01 8.7478E-01 1.5996E-01 1.4689E 00 3.6126E-01

-1.1407E 00 +1.0123E 01 6.0767E-01 1.6456E 00 6.2068E-01 1.6111E 00 1.6213E 00 1.1197E-01 1.0214E 00 4.9264E-01

-1.1744E 00 +1.1619E 01 5.9922E-01 1.6943E 00 5.4075E-01 1.8493E 00 1.8587E 00 1.0056E-01 9.1618E-01 5.2951E-01

CASE 1 4 TEST DATA FROM FULLY HORIZONTAL

PCIP CABLES HORIZONTAL
NO SNOOPERS

NC LIFT/ANTI-LIFT CABLE

DATA CHANGE

5 6.2000

6 -C.80000

70 C.C

74 80.000

81 26.400

87 8.4000

91 C.80000

C C.O

EH. ATT. DEPTIN. & CABLE TENSION

THETA = 2.51 DEG

DELTA = -2.12 DEG

SET CABLE TENSION = C.120000 C.100

RP CABLE TENSION = 0.140039E 03 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D

-2.9475E-01 +5.5731E 00 2.3517E 00 4.2523E-01

-6.6118E-01 +8.0001E 00 1.0404E 00 5.5388E-01

>>>> INTEGRAL/DIFFERENTIAL STABILITY <<<<

REAL IMAGINARY T F/D-SEC 1/T F/D

-1.7860E 00 +2.7053E 00 3.8811E-01 2.5766E 00

-1.4335E 00 +7.2026E 00 4.8352E-01 2.0682E 00

-5.1859E-01 +9.7303E 00 1.3366E 00 7.4816E-01

UNDMAT-CPS	DAMP RATIO	DECAY RATIO
8.8822E-01	5.2815E-02	4.7941E-01
1.2789E 00	8.2284E-02	7.4841E-01

UNDMAT-CPS	DAMP RATIO	DECAY RATIO
5.1593E-01	5.5093E-01	5.9841E 00
1.1688E 00	1.9520E-01	1.8042E 00
1.5508E 00	5.3222E-02	4.8311E-01

CASE NO= 1 TEST DATA IRC
FACIAL CARE VERTICAL, FEAR CPELE HORIZONTAL
NO SUBSERIES

NC 1111/AN11-1111 CAREE

INPUT DATA AS SPECIFIED IN AERC ARRAY

AERO(1)= 0.0	AERC(2)= 0.0	AERO(3)= 0.0	AERO(4)= 0.0	AERO(5)= 6.26
AERO(6)= 0.0	AERO(7)= 0.0	AERO(8)= 0.0	AERO(9)= -0.00	AERO(10)= 0.180E-01
AERO(11)= 0.10E	AERO(12)= 0.350E-01	AERO(13)= 0.0	AERO(14)= 0.960	AERO(15)= -1.50
AERO(16)= 0.0	AERO(17)= 0.0	AERO(18)= 0.0	AERO(19)= -0.730	AERO(20)= -0.350E-01
AERO(21)= 0.111	AERO(22)= 0.0	AERO(23)= -0.190	AERO(24)= -0.100E-01	AERO(25)= 0.0
AERO(26)= 0.500E-01	AERO(27)= -0.920E-01	AERO(28)= 0.0	AERO(29)= 0.0	AERO(30)= 0.0
AERO(31)= 0.0	AERO(32)= 0.0	AERO(33)= 0.0	AERO(34)= 0.0	AERO(35)= 0.0
AERO(36)= 0.0	AERO(37)= 0.0	AERO(38)= 0.0	AERO(39)= 0.0	AERO(40)= 0.0
AERO(41)= 0.0	AERO(42)= 0.0	AERO(43)= 0.0	AERO(44)= 0.0	AERO(45)= 0.0
AERO(46)= 0.0	AERO(47)= 0.0	AERO(48)= 0.0	AERO(49)= 0.0	AERO(50)= 4.35
AERO(51)= 0.350E-03	AERO(52)= 1.0	AERO(53)= 9.76	AERO(54)= 1.40	AERO(55)= 11.5
AERO(56)= 0.110	AERO(57)= 1.90	AERO(58)= 14.0	AERO(59)= 14.0	AERO(60)= 0.0
AERO(61)= 0.0	AERO(62)= 0.0	AERO(63)= 0.0	AERO(64)= 0.0	AERO(65)= 0.0
AERO(66)= 0.0	AERO(67)= -0.0	AERO(68)= 0.0	AERO(69)= 0.0	AERO(70)= 0.0
AERO(71)= 0.0	AERO(72)= 10.0	AERO(73)= 0.0	AERO(74)= 0.0	AERO(75)= 80.0
AERO(76)= 0.0	AERO(77)= 175	AERO(78)= 0.0	AERO(79)= 26.4	AERO(80)= 0.0
AERO(81)= 0.0	AERO(82)= 0.0	AERO(83)= 8.40	AERO(84)= 0.0	AERO(85)= 0.0
AERO(86)= 0.0	AERO(87)= 0.0	AERO(88)= 0.920	AERO(89)= 0.0	AERO(90)= 0.880
AERO(91)= 0.0	AERO(92)= 0.0	AERO(93)= 0.880	AERO(94)= 140.	AERO(95)= 3.00
AERO(96)= 0.0	AERO(97)= 177	AERO(98)= -0.960	AERO(99)= 0.0	AERO(100)= 0.0
AERO(101)= 0.0	AERO(102)= -2.00	AERO(103)= 3.00	AERO(104)= 0.500E-01	AERO(105)= 2.00
AERO(106)= 0.0	AERO(107)= 2.00	AERO(108)= 2.00	AERO(109)= 3.00	AERO(110)= 2.00
AERO(111)= 1.0	AERO(112)= 96.0	AERO(113)= 72.0	AERO(114)= 180.	AERO(115)= -96.0
AERO(116)= 72.0	AERO(117)= 80.0	AERO(118)= 80.0	AERO(119)= 50.0	AERO(120)= 50.0
AERO(121)= 5.00	AERO(122)= 5.00	AERO(123)= 0.0	AERO(124)= 0.0	AERO(125)= 0.0
AERO(126)= 0.0	AERO(127)= 0.0	AERO(128)= 0.0	AERO(129)= 0.0	AERO(130)= 0.0

>>>> FOOT LOCUS VARYING AREA(54)

AREA(54) = 24.000

EF. ATT., DEFLECTION, CABLE TENSION

THETA = 2.26 DEG

DELTA = -0.61 DEG

PRT CAB. TENSION = 0.740171E 02 LBS

EF CAB. TENSION = 0.840000E 02 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

-4.1172E-01 +1.5224E 00 1.6862E 00 5.9306E-01 1.3893E 00 7.1976E-01 7.2273E-01 9.0527E-02 8.2357E-01 5.6488E-01

-7.6146E-01 +7.3156E 00 9.0775E-01 1.1016E 00 8.5564E-01 1.1629E 00 1.1629E 00 1.0394E-01 9.4733E-01 5.1859E-01

>>>> LATERAL/DEFECTIONAL STABILITY <<<<

REAL IMAGINARY T F/C-SEC

-8.0267E-01 +3.4205E 00 8.6355E-01 1.1580E 00 1.9508E 00 5.1262E-01 5.2830E-01 2.4181E-01 2.2590E 00 2.0891E-01

-1.9927E 00 +4.0231E 00 3.4784E-01 2.8749E 00 1.5618E 00 6.4029E-01 7.1433E-01 4.4386E-01 4.4900E 00 4.9501E-02

-3.9774E-01 +5.1582E 00 1.7427E 00 5.7382E-01 1.2984E 00 1.2984E 00 1.3000E 00 4.8657E-02 4.8158E-01 7.3614E-01

AREA(54) = 59.000

EF. ATT., DEFLECTION, CABLE TENSION

THETA = 2.26 DEG

DELTA = -0.61 DEG

PRT CAB. TENSION = 0.456992E 02 LBS

EF CAB. TENSION = 0.560000E 02 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

-4.6231E-01 +1.5735E 00 1.5003E 00 1.5003E-01 1.3256E 00 7.5438E-01 7.5796E-01 9.7010E-01 8.8356E-01 5.4203E-01

-7.1271E-01 +7.4611E 00 9.7310E-01 1.0276E 00 8.2551E-01 1.2114E 00 1.2167E 00 9.3179E-02 8.4832E-01 5.5543E-01

>>>> LATERAL/DEFECTIONAL STABILITY <<<<

REAL IMAGINARY T F/C-SEC

-9.1741E-01 +3.4205E 00 7.5555E-01 1.3235E 00 1.9294E 00 5.1830E-01 5.3847E-01 2.7116E-01 2.5536E 00 1.7033E-01

-1.8649E 00 +4.5973E 00 3.7176E-01 2.6899E 00 1.3667E 00 7.3168E-01 7.8956E-01 3.7584E-01 3.6764E 00 7.8218E-02

-1.1331E-01 +2.8915E 00 1.6851E 00 5.9342E-01 7.3953E-01 1.3515E 00 1.3531E 00 4.8384E-02 4.3907E-01 7.3760E-01

AREA(54) = 112.00

EF. ATT., DEFLECTION, CABLE TENSION

THETA = 2.26 DEG

DELTA = -0.61 DEG

PRT CAB. TENSION = 0.972730E 02 LBS

EF CAB. TENSION = 0.112031E 03 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

-5.0655E-01 +1.9207E 00 1.3673E 00 7.3136E-01 1.2753E 00 7.8411E-01 7.8825E-01 1.0236E-01 9.3272E-01 5.2387E-01

-6.6702E-01 +7.3166E 00 1.0392E 00 9.6230E-01 7.9347E-01 1.2603E 00 1.2647E 00 8.3938E-02 7.6356E-01 5.8904E-01

>>>> LATERAL/DEFECTIONAL STABILITY <<<<

REAL IMAGINARY T F/C-SEC

-9.5880E-01 +3.4205E 00 7.2293E-01 1.3833E 00 1.9028E 00 5.4726E-01 5.4726E-01 2.7884E-01 2.6320E 00 1.6132E-01

-1.8107E 00 +5.1177E 00 3.8281E-01 2.6123E 00 1.2277E 00 8.1450E-01 8.6398E-01 3.3355E-01 3.2072E 00 1.0828E-01

-0.2385E-01 +1.4130E 00 1.6350E 00 6.1160E-01 7.1295E-01 1.4926E 00 1.4943E 00 4.8035E-02 4.3556E-01 7.3920E-01

AREA(54) = 126.00

EF. ATT., DEFLECTION, CABLE TENSION

THETA = 2.26 DEG

DELTA = -0.73 DEG

PRT CAB. TENSION = 0.109046E 03 LBS

FF CBL. TENSION = 0.122031E 03 IBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY

	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.4556E-01	1.2765E 00	1.2344E 00	8.1013E-01	8.1477E-01	1.6557E-01	9.7154E-01
-6.2802E-01	1.1037E 00	7.6393E-01	1.3090E 00	1.3128E 00	7.6136E-02	6.9215E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY

	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.7347E-01	1.4044E 00	1.8651E 00	5.3618E-01	5.5811E-01	2.7760E-01	2.6193E 00
-1.7244E 00	2.5744E 00	1.1259E 00	8.8817E-01	9.3247E-01	3.0457E-01	2.8952E 00
-4.3552E-01	6.2833E-01	6.8970E-01	1.4520E 00	1.5537E 00	4.7664E-02	4.3273E-01

AEPG(94) = 140.00

EF. ATT., DEFLECTION CABLE TENSION

TFFA = 2.45 DEG

DELTA = -0.66 DEG

FF CBL. TENSION = 0.120702E 03 IBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY

	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.7555E-01	1.1945E 00	1.1959E 00	8.3340E-01	8.3847E-01	1.0979E-01	1.0072E 00
-5.9472E-01	1.1653E 00	7.3678E-01	1.3573E 00	1.3606E 00	6.9575E-02	6.4517E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY

	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-9.7642E-01	1.4116E 00	1.8221E 00	5.4882E-01	5.7049E-01	2.7257E-01	2.5721E 00
-1.7695E 00	2.5514E 00	1.0471E 00	9.5508E-01	9.9568E-01	2.8269E-01	2.6715E 00
-4.4653E-01	6.4420E-01	6.6674E-01	1.4998E 00	1.5015E 00	4.7331E-02	4.2951E-01

AEPG(94) = 154.00

EF. ATT., DEFLECTION CABLE TENSION

TFFA = 2.32 DEG

DELTA = -0.66 DEG

FF CBL. TENSION = 0.132393E 03 IBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY

	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-6.6417E-01	1.1055E 00	1.1737E 00	8.5400E-01	8.6003E-01	1.7121E-01	1.0233E 00
-5.6462E-01	1.2233E 00	7.1169E-01	1.4047E 00	1.4076E 00	6.4065E-02	5.8192E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY

	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-9.7944E-01	1.4130E 00	1.7776E 00	5.6255E-01	5.8375E-01	2.6704E-01	2.5119E 00
-1.7572E 00	2.5351E 00	9.8346E-01	1.0169E 00	1.0546E 00	2.6519E-01	2.9312E 00
-4.5659E-01	6.5930E-01	6.4672E-01	1.5463E 00	1.5480E 00	4.6986E-02	4.2638E-01

AEPG(94) = 168.00

EF. ATT., DEFLECTION CABLE TENSION

TFFA = 2.22 DEG

DELTA = -1.11 DEG

FF CBL. TENSION = 0.140007E 03 IBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY

	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-6.2976E-01	1.1707E 00	1.1745E 00	8.7413E-01	8.7922E-01	1.1390E-01	1.0392E 00
-5.4266E-01	1.2773E 00	6.8902E-01	1.4513E 00	1.4539E 00	5.9444E-02	5.3543E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY

	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.7662E-01	1.4118E 00	1.7336E 00	5.7683E-01	5.9749E-01	2.6067E-01	2.4475E 00
-1.7481E 00	2.5220E 00	9.3066E-01	1.0745E 00	1.1099E 00	2.5066E-01	2.3471E 00
-4.6791E-01	6.7376E-01	6.2838E-01	1.5914E 00	1.5931E 00	4.6656E-02	4.2338E-01

AEPG(94) = 182.00

PH. ATT. DEFLECTION & CABLE TENSION

THETA = 2.35 DEG
 DELTA = -1.25 DEG
 FPI CABLE TENSION = 0.155741E 03 IBS
 RF CABLE TENSION = 0.162034E 03 IBS
 >>> LONGITUDINAL STABILITY <<<<
 REAL IMAGINARY T W/D-SEC
 -6.4569E-01 +5.6779E 00 1.0669E 00 5.3730E-01 1.1204E 00 8.9253E-01 1.1505E-01 1.0502E 00 4.8291E-01
 -5.2223E-01 +9.4059E 00 1.3273E 00 7.5341E-01 6.6801E-01 1.4570E 00 5.5437E-02 5.0329E-01 7.0550E-01
 >>> LATERAL/DIRECTIONAL STABILITY <<<<
 REAL IMAGINARY T P/D-SEC
 -9.7690E-01 +3.7156E 00 7.0954E-01 1.4054E 00 5.5136E-01 2.5428E-01 2.3833E 00 1.9168E-01
 -1.7402E 00 +7.0830E 00 3.5831E-01 2.5106E 00 1.1289E 00 2.3828E-01 2.2240E 00 2.1405E-01
 -4.7668E-01 +1.0275E 01 1.1501E 00 6.8771E-01 1.6350E 00 4.6343E-02 4.2053E-01 7.4715E-01
 AERCA 94J = 196.00

PH. ATT. DEFLECTION & CABLE TENSION

THETA = 4.35 DEG
 DELTA = -1.40 DEG
 FPI CABLE TENSION = 0.167144E 03 IBS
 RF CABLE TENSION = 0.196035E 03 IBS
 >>> LONGITUDINAL STABILITY <<<<
 REAL IMAGINARY T W/D-SEC
 -6.4575E-01 +5.7166E 00 1.0669E 00 5.6191E-01 1.0561E 00 9.0985E-01 1.1585E-01 1.0572E 00 4.8056E-01
 -5.0473E-01 +9.6866E 00 1.3734E 00 7.2413E-01 6.4865E-01 1.5417E 00 5.2034E-02 4.7230E-01 7.2081E-01
 >>> LATERAL/DIRECTIONAL STABILITY <<<<
 REAL IMAGINARY T P/D-SEC
 -9.7482E-01 +3.8074E 00 7.1105E-01 1.4064E 00 6.0597E-01 2.4803E-01 2.3205E 00 2.0015E-01
 -1.7330E 00 +7.4170E 00 3.9986E-01 2.5002E 00 1.1805E 00 2.2753E-01 2.1180E 00 2.3036E-01
 -4.8656E-01 +1.0545E 01 1.4260E 00 7.0124E-01 5.9587E-01 4.6047E-02 4.1785E-01 7.4854E-01

CASE NO. 2 TEST DATA UNSHIPPED SNODREF
FECN1 CABLE VERTICAL, REAF CAELE FORZONTAL
SNODREFS UNSHIPPED
DC 1157/ANTI-1157 CAELE

DATA CHANGE
C C.O.

>>>> FOOT LOCUS VARYING AERC (94)

AERC (94) = 94.200

PH. ATT., DELTA, & CABLE TENSION

THETA = 2.26 DEG

DELTA = -0.68 DEG

FRT CAE. TENSION = 0.132459E 03 LBS

>>> LONGITUDINAL STABILITY <<<

REAL IMAGINARY T H/D-SEC

-5.0259E-01 +-5.0653E 00 1.3792E 00 7.2508E-01 1.1445E 00 8.6912E-01 9.1566E-02 8.3357E-01 5.6116E-01

-6.7174E-01 +-8.2834E 00 1.0329E 00 9.6814E-01 7.5853E-01 1.3183E 00 1.3227E 00 8.0750E-02 7.3436E-01 6.0108E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL IMAGINARY T F/L-SEC

-7.7711E-01 +-4.6442E 00 5.5155E-01 1.1211E 00 7.7098E-01 7.8083E-01 1.5840E-01 1.4542E 00 3.6496E-01

-1.2905E 00 +-8.1265E 00 5.3713E-01 1.8618E 00 1.2934E 00 1.3096E 00 1.5680E-01 1.4355E 00 3.6869E-01

-1.1258E 00 +-9.5515E 00 6.1571E-01 1.6241E 00 6.8478E-01 1.5042E 00 1.5149E 00 1.1827E-01 1.0797E 00 8.7313E-01

>>> DAMP RATIO

AERC (94) = 98.220

PH. ATT., DELTA, & CABLE TENSION

THETA = 2.28 DEG

DELTA = -0.40 DEG

FRT CAE. TENSION = 0.126455E 03 LBS

>>> LONGITUDINAL STABILITY <<<

REAL IMAGINARY T H/D-SEC

-5.9410E-01 +-5.7676E 00 1.2812E 00 7.8065E-01 1.1159E 00 8.9294E-01 9.6000E-02 8.7424E-01 5.4554E-01

-6.3216E-01 +-8.5786E 00 1.0658E 00 5.4201E-01 7.3242E-01 1.3653E 00 7.3492E-02 6.6758E-01 6.2939E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL IMAGINARY T H/D-SEC

-8.0141E-01 +-4.9230E 00 9.6491E-01 1.1562E 00 7.8352E-01 7.9383E-01 1.6066E-01 1.4756E 00 3.5957E-01

-1.2505E 00 +-8.4024E 00 5.5430E-01 1.8041E 00 1.3373E 00 1.3520E 00 1.4720E-01 1.3491E 00 3.5255E-01

-1.1416E 00 +-9.7485E 00 6.0717E-01 1.6470E 00 6.4466E-01 1.5512E 00 1.5618E 00 1.0617E 00 8.7905E-01

>>> DAMP RATIO

AERC (94) = 112.00

PH. ATT., DELTA, & CABLE TENSION

THETA = 2.34 DEG

DELTA = -0.63 DEG

FRT CAE. TENSION = 0.132459E 03 LBS

>>> LONGITUDINAL STABILITY <<<

REAL IMAGINARY T H/D-SEC

-5.7377E-01 +-5.7409E 00 1.2180E 00 8.2780E-01 1.0345E 00 9.1369E-01 9.1825E-01 9.9452E-02 9.0559E-01 5.3157E-01

-5.9307E-01 +-8.9712E 00 1.1570E 00 8.6428E-01 7.0827E-01 1.4119E 00 1.4151E 00 6.7377E-02 6.1214E-01 6.5423E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL IMAGINARY T F/L-SEC

-8.2059E-01 +-4.9556E 00 8.4470E-01 1.1639E 00 7.5561E-01 7.5561E-01 1.6198E-01 1.4880E 00 3.5651E-01

-1.2159E 00 +-9.6700E 00 5.6201E-01 1.7600E 00 7.2470E-01 1.3799E 00 1.3933E-01 1.2754E 00 4.1310E-01

-1.1531E 00 +-1.0034E 01 6.0717E-01 1.6836E 00 6.2622E-01 1.5969E 00 1.6074E 00 1.1417E-01 1.0418E 00 8.8514E-01

>>> DAMP RATIO

AERC (94) = 126.00

PH. ATT., DELTA, & CABLE TENSION

THETA = 2.22 DEG

DELTA = -1.06 DEG

FRT CAE. TENSION = 0.145632E 03 LBS

PH. ATT., DEFLECTION, 6 CABLE TENSION

THETA = 2.35 DEG

DELTA = -1.20 DEG

FRI. CAP. TENSION = 0.15556E-03 LBS

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PH. CAP. TENSION = 0.15556E-03 LBS

EF, ATT., DEFLTN., & CABLE TENSION

THETA = 2.44 DEG
 DELTA = -1.65 DEG
 REF. CABLE TENSION = C.190027E C3 LBS
 REF. CABLE TENSION = 0.182037E 03 LBS
 >>> LONGITUDINAL STABILITY <<<<
 REAL IMAGINARY T F/L-SEC 1/T H/D PERIOD-SEC DNATP-CPS UNDNAT-CFS DAMP RATIO DECAF RATIO
 -6.7577E-01 +6.2709E-00 1.0283E-01 5.7555E-01 1.0020E-00 9.9803E-01 1.0039E-00 1.0722E-01 9.7758E-01 5.0733E-01
 -4.9429E-01 +1.0241E-01 1.4023E-00 7.1311E-01 6.1235E-01 1.6331E-00 1.6350E-00 4.8117E-02 4.3662E-01 7.3894E-01
 >>> LATERAL/BISECTIONAL STABILITY <<<<
 REAL IMAGINARY T H/D-SEC 1/T H/D PERIOD-SEC DNATP-CPS UNDNAT-CFS DAMP RATIO DECAF RATIO
 -6.7332E-01 +5.3568E-00 7.9359E-01 1.2601E-00 1.1729E-00 8.5256E-01 8.6382E-01 1.6093E-01 1.4762E-00 3.5898E-01
 -1.1466E-00 +9.9972E-01 6.0453E-01 1.6542E-00 6.3469E-01 1.5752E-00 1.5857E-00 1.1508E-01 1.0501E-00 4.8292E-01
 -1.1741E-00 +1.1355E-01 5.5036E-01 1.6939E-00 5.5267E-01 1.8094E-00 1.8190E-00 1.0273E-01 9.3616E-01 5.2267E-01
 AERC(94) = 196.00

EF, ATT., DEFLTN., & CABLE TENSION

THETA = 2.45 DEG
 DELTA = -1.61 DEG
 REF. CABLE TENSION = C.202213E C3 LBS
 REF. CABLE TENSION = C.190037E C3 LBS
 >>> LONGITUDINAL STABILITY <<<<
 REAL IMAGINARY T F/L-SEC 1/T H/D PERIOD-SEC DNATP-CPS UNDNAT-CFS DAMP RATIO DECAF RATIO
 -6.8255E-01 +5.3623E-00 1.0062E-01 5.9379E-01 9.8756E-01 1.0126E-00 1.0185E-00 1.0762E-01 9.8103E-01 5.0609E-01
 -4.8119E-01 +1.0522E-01 1.4405E-00 6.8421E-01 5.9712E-01 1.6747E-00 1.6764E-00 4.5683E-02 4.1453E-01 7.5026E-01
 >>> LATERAL/BISECTIONAL STABILITY <<<<
 REAL IMAGINARY T H/D-SEC 1/T H/D PERIOD-SEC DNATP-CPS UNDNAT-CFS DAMP RATIO DECAF RATIO
 -8.7919E-01 +5.4256E-00 7.6635E-01 1.2680E-00 1.1581E-00 8.6351E-01 8.7478E-01 1.5996E-01 1.4689E-00 3.6126E-01
 -1.1467E-00 +1.0133E-01 6.0767E-01 1.6456E-00 6.2068E-01 1.6111E-00 1.6213E-00 1.1157E-01 1.0214E-00 4.9264E-01
 -1.1744E-00 +1.1619E-01 5.9322E-01 1.6943E-00 5.4075E-01 1.8493E-00 1.8587E-00 1.0056E-01 9.1618E-01 5.2991E-01

CASE NO= 3 TEST DATA CHANGE C1 AND C4 ALPHA
FRONT CABLE VERTICAL, REAR CABLE HORIZONTAL
AC SQUARES

NO LIFT/ANTI-LIFT CABLE

DATA CHANGE

5 5.5000
5 -1.3000
0 0.0

FF. ATT., DEFLECTION, & CABLE TENSION

THEIR = 2.94 DEG

DELTA = -2.78 DEG

PRI CAP. TENSION = 0.120742E 03 LBS

FF CAP. TENSION = 0.100000E 03 LBS

>>> INSTABILITY STABILITY <<<

REAL IMAGINARY T H/D-SEC

-3.9605E-01 +4.5501E 00 1.7502E 00 5.7138E-01 1.3899E 00 6.2824E-01

-6.8065E-01 +9.9917E 00 1.0184E 00 5.8197E-01 1.5902E 00 6.2824E-01

PERIOD-SEC

1.3899E 00

6.2824E-01

ENATF-CPS

7.2418E-01

1.5939E 00

UNENAT-CPS

7.2691E-01

1.5939E 00

DAMP RATIO

8.6714E-02

6.7965E-02

DECAY RATIO

7.6900E-01

6.1750E-01

5.7874E-01

6.5160E-01

CASE NO-

1 TEST DATA IRC

PERCENT CABLE VERTICAL, RENE CABLE HORIZONTAL

NO SMOOTHERS

NC LIFT/ANTI-LIFT CABLE

INPUT DATA AS SPECIFIED IN AERC ARRAY

AERO(1) = 0.0	AERC(2) = 0.0	AERO(3) = 0.0	AERO(4) = 0.0	AERO(5) = 6.26
AERO(6) = -0.810	AERO(7) = 0.0	AERC(8) = 0.0	AERO(9) = -8.00	AERO(10) = 0.180E-01
AERC(11) = 0.105	AERC(12) = 0.350E-01	AERC(13) = 0.0	AERO(14) = 0.960	AERO(15) = -1.50
AERO(16) = 0.0	AERC(17) = 0.0	AERO(18) = 0.0	AERO(19) = -0.730	AERC(20) = -0.350E-01
AERO(21) = 0.111	AERO(22) = 0.0	AERC(23) = -0.190	AERO(24) = -0.100E-01	AERO(25) = 0.0
AERO(26) = 0.500E-01	AERC(27) = -0.920E-01	AERO(28) = 0.0	AERO(29) = 0.0	AERO(30) = 0.0
AERC(31) = 0.0	AERO(32) = 0.0	AERO(33) = 0.0	AERO(34) = 0.0	AERO(35) = 0.0
AERC(36) = 0.0	AERO(37) = 0.0	AERC(38) = 0.0	AERO(39) = 0.0	AERO(40) = 0.0
AERO(41) = 0.0	AERC(42) = 0.0	AERO(43) = 0.0	AERO(44) = 0.0	AERO(45) = 0.0
AERO(46) = 0.0	AERO(47) = 0.0	AERO(48) = 0.800	AERO(49) = 430.	AERC(50) = 4.35
AERO(51) = 0.500E-01	AERO(52) = 140.	AERC(53) = 9.16	AERO(54) = 1.40	AERO(55) = 11.5
AERC(56) = -0.110	AERC(57) = 1.80	AERO(58) = 14.0	AERO(59) = 14.0	AERC(60) = 0.0
AERO(61) = 0.0	AERO(62) = 0.0	AERC(63) = 0.0	AERC(64) = 0.0	AERO(65) = 0.0
AERC(66) = 59.0	AERC(67) = -59.0	AERC(68) = 0.0	AERO(69) = 0.0	AERO(70) = 0.0
AERO(71) = 0.0	AERC(72) = 10.0	AERO(73) = 285.	AERO(74) = 0.0	AERO(75) = 80.0
AERO(76) = 0.0	AERO(77) = 175.	AERC(78) = 0.0	AERC(79) = 26.4	AERO(80) = 0.0
AERO(81) = 0.0	AERC(82) = 8.00	AERO(83) = 8.40	AERO(84) = 8.40	AERO(85) = 0.0
AERO(86) = 0.0	AERO(87) = 0.0	AERO(88) = 0.920	AERO(89) = 0.0	AERC(90) = 0.880
AERO(91) = 0.0	AERO(92) = 0.0	AERC(93) = 0.880	AERO(94) = 140.	AERO(95) = 3.00
AERO(96) = 0.0	AERC(97) = 177.	AERO(98) = -0.960	AERO(99) = 0.0	AERO(100) = 0.0
AERO(101) = 0.0	AERO(102) = -2.00	AERO(103) = 3.00	AERO(104) = 0.500E-01	AERO(105) = 2.00
AERO(106) = 3.00	AERO(107) = 2.00	AERC(108) = 2.00	AERO(109) = 3.00	AERO(110) = 2.00
AERO(111) = 180.	AERC(112) = 96.0	AERO(113) = 72.0	AERO(114) = 180.	AERC(115) = -96.0
AERO(116) = 72.0	AERO(117) = 80.0	AERO(118) = 80.0	AERO(119) = 50.0	AERO(120) = 50.0
AERO(121) = 5.00	AERO(122) = 5.00	AERC(123) = 0.0	AERO(124) = 0.0	AERO(125) = 0.0
AERO(126) = 0.0	AERO(127) = 0.0	AERO(128) = 0.0	AERO(129) = 0.0	AERO(130) = 0.0

>>>> ST LOCUS VARYING AERO (94)

AERO (94) = 84.000

EH. ATT., DEFLIN, & CABLE TENSION

THETA = 2.20 DEG

DELTA = -0.39 DEG

PRT CAB. TENSION = 0.740171E 02 LBS

RR CAE. TENSION = C.84C3CE C2 LBS

>>> ICNGITUINDIAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

1/T H/D

PERIOD-SEC

DNATP-CPS

UNDNAT-CPS

DAMP RATIO

DECAY RATIO

-4.1108E-01 +4.5224E 00 1.6862E 00 5.9306E-01 1.3893E 00 7.1976E-01 9.0527E-02 8.2357E-01 5.6488E-01

-7.6359E-01 +7.3066E 00 9.0775E-01 1.1016E 00 8.5954E-01 1.1629E 00 1.0394E-01 9.4733E-01 5.1859E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T E/C-SEC

1/T E/C

PERIOD-SEC

DNATP-CPS

UNDNAT-CPS

DAMP RATIO

DECAY RATIO

-8.0267E-01 +3.2209E 00 8.6355E-01 1.1580E 00 1.9508E 00 5.1262E-01 2.4181E-01 2.2590E 00 2.0891E-01

-1.9927E 00 +4.0231E 00 3.4784E-01 2.8749E 00 1.5618E 00 6.4029E-01 4.4386E-01 4.4900E 00 4.4501E-02

-3.9774E-01 +8.1582E 00 1.7427E 00 5.7382E-01 7.7017E-01 1.2984E 00 4.8657E-02 4.4154E-01 7.3614E-01

AERC (94) = 98.000

EH. ATT., DEFLIN, & CABLE TENSION

THETA = 2.22 DEG

DELTA = -0.50 DEG

PRT CAB. TENSION = 0.856892E 02 LBS

RR CAE. TENSION = C.9EC3CE C2 LBS

>>> ICNGITUINDIAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

1/T H/D

PERIOD-SEC

DNATP-CPS

UNDNAT-CPS

DAMP RATIO

DECAY RATIO

-4.6201E-01 +4.7355E 00 1.5003E 00 6.6654E-01 1.3256E 00 7.5838E-01 9.7014E-02 8.8350E-01 5.4203E-01

-7.1231E-01 +7.6113E 00 9.7310E-01 1.0276E 00 8.2551E-01 1.2114E 00 9.3179E-02 8.4832E-01 5.5543E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T E/C-SEC

1/T E/C

PERIOD-SEC

DNATP-CPS

UNDNAT-CPS

DAMP RATIO

DECAY RATIO

-9.1741E-01 +3.2566E 00 7.5555E-01 1.3235E 00 1.9294E 00 5.1830E-01 2.7116E-01 2.5536E 00 1.7033E-01

-1.8645E 00 +4.5973E 00 3.7176E-01 2.6899E 00 1.3667E 00 7.3168E-01 3.7584E-01 3.6764E 00 7.8218E-02

-4.1133E-01 +8.4515E 00 1.6851E 00 5.9342E-01 7.3953E-01 1.3515E 00 4.8384E-02 4.3909E-01 7.3760E-01

AERC (94) = 112.00

EH. ATT., DEFLIN, & CABLE TENSION

THETA = 2.24 DEG

DELTA = -0.61 DEG

PRT CAB. TENSION = 0.972730E 02 LBS

RR CAE. TENSION = C.112C31E C3 LBS

>>> ICNGITUINDIAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

1/T H/D

PERIOD-SEC

DNATP-CPS

UNDNAT-CPS

DAMP RATIO

DECAY RATIO

-5.0694E-01 +4.9267E 00 1.3673E 00 7.3136E-01 1.2753E 00 7.8411E-01 1.0236E-01 9.3272E-01 5.2387E-01

-6.6702E-01 +7.9186E 00 1.0392E 00 9.6230E-01 7.9347E-01 1.2603E 00 8.3938E-02 7.6356E-01 5.8904E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T E/C-SEC

1/T E/C

PERIOD-SEC

DNATP-CPS

UNDNAT-CPS

DAMP RATIO

DECAY RATIO

-9.5880E-01 +3.3021E 00 7.2293E-01 1.3833E 00 1.9028E 00 5.2555E-01 2.7884E-01 2.6320E 00 1.6132E-01

-1.8107E 00 +5.1177E 00 3.8281E-01 2.6123E 00 1.2277E 00 8.1450E-01 3.3355E-01 3.2072E 00 1.0828E-01

-4.2385E-01 +8.8130E 00 1.6354E 00 6.1148E-01 7.1295E-01 1.4026E 00 4.8035E-02 4.3556E-01 7.3920E-01

AERC (94) = 126.00

EH. ATT., DEFLIN, & CABLE TENSION

THETA = 2.26 DEG

DELTA = -0.73 DEG

PRT CAB. TENSION = 0.109046E 03 LBS

PR CAB. TENSION = 0.12603E 03 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.4556E-01	+5.0902E 00	1.2705E 00	7.8707E-01	1.2384E 00	.1013E-01	8.1477E-01	1.0657E-01	9.7158E-01
-6.2802E-01	+8.2248E 00	1.1037E 00	9.0604E-01	7.6393E-01	1.3090E 00	1.3128E 00	7.6136E-02	6.9215E-01
>>>> LATERAL/DIRECTIONAL STABILITY <<<<								
REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.7347E-01	+3.3689E 00	7.1204E-01	1.4044E 00	1.8651E 00	5.3618E-01	5.5811E-01	2.7760E-01	2.6193E 00
-1.7844E 00	+5.5806E 00	3.8844E-01	2.5744E 00	1.1259E 00	8.8817E-01	9.3247E-01	3.0457E-01	2.8985E 00
-4.3552E-01	+9.1233E 00	1.5915E 00	6.2833E-01	6.8870E-01	1.4520E 00	1.4537E 00	4.7684E-02	4.3273E-01

AERC(94) = 140.00

EH. ATT., DEFLECTN, & CABLE TENSION

THETA = 2.28 DEG

DELTA = -0.85 DEG

FET CAB. TENSION =

RR CAB. TENSION = 0.140032E 03 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.7838E-01	+5.2364E 00	1.1584E 00	8.3443E-01	1.1999E 00	8.3340E-01	8.3847E-01	1.0979E-01	1.0012E 00
-5.9480E-01	+8.5279E 00	1.1653E 00	8.5812E-01	7.3678E-01	1.3573E 00	1.3606E 00	6.9579E-02	6.3225E-01
>>>> LATERAL/DIRECTIONAL STABILITY <<<<								
REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-9.7846E-01	+3.4483E 00	7.0841E-01	1.4116E 00	1.8221E 00	5.4882E-01	5.7049E-01	2.7297E-01	2.5721E 00
-1.7685E 00	+6.0088E 00	3.9193E-01	2.5514E 00	1.0471E 00	9.5506E-01	9.9568E-01	2.8269E-01	2.6715E 00
-4.4653E-01	+9.4238E 00	1.5523E 00	6.4420E-01	6.6674E-01	1.4998E 00	1.5015E 00	4.7331E-02	4.2951E-01

AERC(94) = 154.00

EF. ATT., DEFLECTN, & CABLE TENSION

THETA = 2.30 DEG

DELTA = -0.98 DEG

FET CAB. TENSION =

RR CAB. TENSION = 0.132393E 03 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-6.0617E-01	+5.3696E 00	1.1435E 00	8.7451E-01	1.1701E 00	8.5460E-01	8.6003E-01	1.1218E-01	1.0233E 00
-5.6662E-01	+8.8262E 00	1.2233E 00	8.1745E-01	7.1188E-01	1.4047E 00	1.4076E 00	6.4065E-02	5.8192E-01
>>>> LATERAL/DIRECTIONAL STABILITY <<<<								
REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-9.7944E-01	+3.5346E 00	7.0770E-01	1.4130E 00	1.7776E 00	5.6255E-01	5.8375E-01	2.6704E-01	2.5118E 00
-1.7572E 00	+6.3888E 00	3.5447E-01	2.5351E 00	9.8346E-01	1.0168E 00	1.0540E 00	2.6519E-01	2.4931E 00
-4.5699E-01	+9.7155E 00	1.5168E 00	6.5930E-01	6.4672E-01	1.5463E 00	1.5480E 00	4.6986E-02	4.2638E-01

AERC(94) = 168.00

EF. ATT., DEFLECTN, & CABLE TENSION

THETA = 2.33 DEG

DELTA = -1.11 DEG

FET CAB. TENSION =

RR CAB. TENSION = 0.144067E 03 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-6.2970E-01	+5.4527E 00	1.1009E 00	9.0846E-01	1.1439E 00	8.7419E-01	8.7992E-01	1.1390E-01	1.0392E 00
-5.4266E-01	+8.1150E 00	1.2773E 00	7.8289E-01	6.8902E-01	1.4513E 00	1.4539E 00	5.9404E-02	5.3943E-01
>>>> LATERAL/DIRECTIONAL STABILITY <<<<								
REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-9.7866E-01	+3.6243E 00	7.0831E-01	1.4118E 00	1.7336E 00	5.7683E-01	5.9749E-01	2.6067E-01	2.4475E 00
-1.7481E 00	+6.7514E 00	3.9652E-01	2.5220E 00	9.3066E-01	1.0745E 00	1.1099E 00	2.5066E-01	2.3471E 00
-4.6701E-01	+9.9950E 00	1.4842E 00	6.7376E-01	6.2838E-01	1.5914E 00	1.5931E 00	4.6656E-02	4.2338E-01

AERC(94) = 182.00

EH. ATT. LIN, & CABLE TENSION

THETA = -35 DEG

DELTA = -1.25 DEG

FRT CAB. TENSION= 0.155741E 03 IBS

RR CAB. TENSION = 0.182034E 03 IBS

>>> LONGITUDINAL STABILITY <<<

REAL IMAGINARY T H/D-SEC

1/T H/D

PERIOD-SEC

DNATF-CPS

UNDNAT-CPS

DAMP RATIO

DECAY RATIO

-6.4969E-01 +5.6079E 00 1.0669E 00 9.3730E-01 1.1204E 00 8.9253E-01 1.1508E-01 1.0502E 00 4.8291E-01

-5.2223E-01 +9.4059E 00 1.3273E 00 7.5341E-01 6.6801E-01 1.4970E 00 5.5437E-02 5.0329E-01 7.0550E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL IMAGINARY T F/L-SEC

1/T F/L

PERIOD-SEC

DNATF-CPS

UNDNAT-CPS

DAMP RATIO

DECAY RATIO

-9.7690E-01 +3.7156E 00 7.0954E-01 1.4094E 00 1.6910E 00 5.5136E-01 2.5428E-01 2.3833E 00 1.9168E-01

-1.7402E 00 +7.0530E 00 3.9831E-01 2.5108E 00 8.8583E-01 1.1289E 00 2.3628E-01 2.2240E 00 2.1405E-01

-4.7668E-01 +1.0275E 01 1.4541E 00 6.8771E-01 6.1145E-01 1.6354E 00 4.6343E-02 4.2053E-01 7.4715E-01

AERO (94) = 196.00

EH. ATT. DEFINT, & CABLE TENSION

THETA = 2.3E DEG

DELTA = -1.40 DEG

FRT CAB. TENSION= 0.167414E 03 IBS

RR CAB. TENSION = 0.196035E 03 IBS

>>> LONGITUDINAL STABILITY <<<

REAL IMAGINARY T H/D-SEC

1/T H/D

PERIOD-SEC

DNATF-CPS

UNDNAT-CPS

DAMP RATIO

DECAY RATIO

-6.6675E-01 +5.7166E 00 1.0396E 00 5.6191E-01 1.0951E 00 9.0985E-01 1.1585E-01 1.0572E 00 4.8056E-01

-5.0470E-01 +9.6866E 00 1.3734E 00 7.2813E-01 6.4865E-01 1.5417E 00 5.2034E-02 4.7230E-01 7.2081E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<

REAL IMAGINARY T H/D-SEC

1/T H/D

PERIOD-SEC

DNATF-CPS

UNDNAT-CPS

DAMP RATIO

DECAY RATIO

-9.7482E-01 +3.8074E 00 7.1105E-01 1.4064E 00 1.6503E 00 6.0597E-01 2.4803E-01 2.3209E 00 2.0015E-01

-1.7330E 00 +7.4170E 00 3.9996E-01 2.5002E 00 8.4713E-01 1.1805E 00 2.2753E-01 2.1180E 00 2.3036E-01

-4.8606E-01 +1.0545E 01 1.4260E 00 7.0124E-01 5.9587E-01 1.6782E 00 4.6047E-02 4.1785E-01 7.4854E-01

CASE 1

2

TEST DATA UNSNUBBED SNOBBERS
FRONT CABLE VERTICAL, REAR CABLE HORIZONTAL
SNOBBERS UNSNUBBED
NO LIFT/ANTI-LIFT CABLE

DATA CHANGE

C 0.0

>>>> AJT LOCUS VARYING AERO (94)

AERO (94) = 84.000

EF. ATT., DEFLEN, & CABLE TENSION

THETA = 2.26 DEG

DELTA = -0.68 DEG

FRT CAB. TENSION = 0.109811E 03 LBS

RE CAE. TENSION = C.84C315E C2 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

PERIOD-SEC 1/T H/D

DNATF-CPS DNATF-CPS

UNDNAT-CPS UNDNAT-CPS

DAMP RATIO DAMP RATIO

DECAY RATIO DECAY RATIO

>>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

PERIOD-SEC 1/T H/D

DNATF-CPS DNATF-CPS

UNDNAT-CPS UNDNAT-CPS

DAMP RATIO DAMP RATIO

DECAY RATIO DECAY RATIO

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

PERIOD-SEC 1/T H/D

DNATF-CPS DNATF-CPS

UNDNAT-CPS UNDNAT-CPS

DAMP RATIO DAMP RATIO

DECAY RATIO DECAY RATIO

>>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

PERIOD-SEC 1/T H/D

DNATF-CPS DNATF-CPS

UNDNAT-CPS UNDNAT-CPS

DAMP RATIO DAMP RATIO

DECAY RATIO DECAY RATIO

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

PERIOD-SEC 1/T H/D

DNATF-CPS DNATF-CPS

UNDNAT-CPS UNDNAT-CPS

DAMP RATIO DAMP RATIO

DECAY RATIO DECAY RATIO

>>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

PERIOD-SEC 1/T H/D

DNATF-CPS DNATF-CPS

UNDNAT-CPS UNDNAT-CPS

DAMP RATIO DAMP RATIO

DECAY RATIO DECAY RATIO

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

PERIOD-SEC 1/T H/D

DNATF-CPS DNATF-CPS

UNDNAT-CPS UNDNAT-CPS

DAMP RATIO DAMP RATIO

DECAY RATIO DECAY RATIO

>>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

PERIOD-SEC 1/T H/D

DNATF-CPS DNATF-CPS

UNDNAT-CPS UNDNAT-CPS

DAMP RATIO DAMP RATIO

DECAY RATIO DECAY RATIO

FR CAB. TENSION = 0.126034E 03 LBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T E/L-SEC 1/T E/L PERIOD-SEC DAMP RATIO DECAY RATIO
-6.0743E-01 +5.8605E 00 1.1522E 00 8.6767E-01 1.0721E 00 9.3762E-01 9.3026E-01 5.2 E-01
-5.7101E-01 +9.1597E 00 1.2139E 00 8.2379E-01 6.8596E-01 1.4578E 00 5.6509E-01 6.7591E-01
>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D PERIOD-SEC DAMP RATIO DECAY RATIO
-8.3589E-01 +5.0730E 00 8.2923E-01 1.2059E 00 1.2386E 00 8.0739E-01 1.4936E 00 3.5512E-01
-1.1965E 00 +8.9298E 00 5.7931E-01 1.7262E 00 7.0362E-01 1.4339E 00 1.3280E-01 4.3090E-01
-1.1613E 00 +1.0313E 01 5.5688E-01 1.6754E 00 6.0924E-01 1.6414E 00 1.1150E-01 4.9287E-01

AERC(94) = 140.00

EH. ATT., DEFLN, & CABLE TENSION

THETA = 2.35 DEG

DELTA = -1.20 DEG

FR CAB. TENSION = 0.155506E 03 LBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D PERIOD-SEC DAMP RATIO DECAY RATIO
-6.2483E-01 +5.9717E 00 1.1093E 00 9.0144E-01 1.0522E 00 9.5043E-01 9.4846E-01 5.1819E-01
-5.4716E-01 +9.4432E 00 1.2668E 00 7.8939E-01 6.6536E-01 1.5029E 00 5.7846E-02 6.9485E-01
>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T E/L-SEC 1/T E/L PERIOD-SEC DAMP RATIO DECAY RATIO
-8.4823E-01 +5.1455E 00 8.1717E-01 1.2237E 00 1.2211E 00 8.1893E-01 1.6265E-01 3.5495E-01
-1.1786E 00 +9.1821E 00 5.8811E-01 1.7004E 00 6.8429E-01 1.4614E 00 1.2732E-01 4.4642E-01
-1.1670E 00 +1.0586E 01 5.9398E-01 1.6836E 00 5.9335E-01 1.6848E 00 1.0957E-01 9.9926E-01 5.0026E-01

AERO(94) = 154.00

EH. ATT., DEFLN, & CABLE TENSION

THETA = 2.37 DEG

DELTA = -1.34 DEG

FR CAB. TENSION = 0.167180E 03 LBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T E/L-SEC 1/T E/L PERIOD-SEC DAMP RATIO DECAY RATIO
-6.4472E-01 +5.6764E 00 1.0751E 00 9.3014E-01 1.0340E 00 9.6709E-01 1.0551E-01 5.1342E-01
-5.2681E-01 +9.7214E 00 1.3157E 00 7.6003E-01 6.4633E-01 1.5472E 00 5.4113E-02 7.1142E-01
>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D PERIOD-SEC DAMP RATIO DECAY RATIO
-8.5829E-01 +5.2169E 00 8.0759E-01 1.2382E 00 1.2044E 00 8.3029E-01 1.6234E-01 3.5568E-01
-1.1649E 00 +9.4272E 00 5.9502E-01 1.6806E 00 6.6650E-01 1.5004E 00 1.2264E-01 4.6005E-01
-1.1707E 00 +1.0853E 01 5.9208E-01 1.6890E 00 5.7896E-01 1.7272E 00 1.0725E-01 9.7784E-01 5.0774E-01

AERC(94) = 168.00

EH. ATT., DEFLN, & CABLE TENSION

THETA = 2.40 DEG

DELTA = -1.49 DEG

FR CAB. TENSION = 0.178853E 03 LBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D PERIOD-SEC DAMP RATIO DECAY RATIO
-6.6170E-01 +6.1757E 00 1.0475E 00 9.5464E-01 1.0174E 00 9.8290E-01 1.0654E-01 9.7124E-01 5.1007E-01
-5.0935E-01 +9.9939E 00 1.3608E 00 7.3484E-01 6.2870E-01 1.5906E 00 5.0902E-02 4.6200E-01 7.2558E-01
>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T E/L-SEC 1/T E/L PERIOD-SEC DAMP RATIO DECAY RATIO
-8.6656E-01 +5.2873E 00 7.5588E-01 1.2502E 00 1.1884E 00 8.4149E-01 1.6174E-01 1.4857E 00 3.5708E-01
-1.1545E 00 +9.6654E 00 6.0040E-01 1.6656E 00 6.5007E-01 1.5383E 00 1.1860E-01 1.0827E 00 4.7214E-01
-1.1730E 00 +1.1113E 01 5.9093E-01 1.6922E 00 5.6537E-01 1.7687E 00 1.0496E-01 9.5675E-01 5.1522E-01

AERC(94) = 182.00

EE. ATT. (1B, 8 CABLE TENSION

THETA = -1.65 DEG

DELTA = -1.65 DEG

PRT CAR. TENSION= 0.190527E C3 IES

RR CAR. TENSION = 0.182037E C3 IES

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

-6.7627E-01 +6.2708E 00 1.0250E 00

-4.9429E-01 +1.0261E 01 1.4023E 00

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

-8.7343E-01 +5.3568E 00 7.9359E-01

-1.1466E 00 +9.4997E 00 6.0453E-01

-1.1741E 00 +1.1369E 01 5.5036E-01

AERC(94) = 156.00

EE. ATT., DEFLIN, 8 CABLE TENSION

THETA = 2.45 DEG

DELTA = -1.61 DEG

PRT CAR. TENSION= 0.202213E C3 IES

RR CAR. TENSION = 0.190037E C3 IES

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

-6.8885E-01 +6.3623E 00 1.0062E 00

-4.8119E-01 +1.0522E 01 1.4405E 00

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

-8.7919E-01 +5.4256E 00 7.8839E-01

-1.1407E 00 +1.0123E 01 6.0767E-01

-1.1744E 00 +1.1619E 01 5.9022E-01

CASE NO

3

TEST DATA CHANGE C1 AND C2 ALPHA
FRONT CABLE VERTICAL, REAR CABLE HORIZONTAL
NO SHOREEYES

NO LIFT/ANTI-LIFT CABLE

DATA CHANGE

5 5.5000

6 -1.3000

0 C.C

EE. ATT., DEFLECTION, & CABLE TENSION

THEIA = 2.94 DEG

DELTA = -2.78 DEG

PRT CAB. TENSION = 0.120742E 03 LBS

RR CAB. TENSION = 0.140053E 03 LBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

-3.9605E-01 +4.5501E 00 1.7502E 00

-6.8065E-01 +9.9917E 00 1.0184E 00

1/T H/D

5.7138E-01

6.2864E-01

PERIOD-SEC

1.3809E 00

6.2864E-01

ENATF-CPS

7.2418E-01

1.5902E 00

UNENAT-CPS

7.2691E-01

1.5939E 00

DAMP RATIO

8.6714E-02

6.7965E-02

DECAY RATIO

7.8900E-01

6.1750E-01

5.7874E-01

6.5180E-01

CASE NO. 4 TEST DATA FRONT FULLY HORIZONTAL

PC18 CABLES HORIZONTAL
NO SMUERS
NC LIFE/ANTI-LIFT CABLE

DATA CHANGE

5 6.2000
6 -C.80000
70 C.C
74 80.000
81 26.400
87 8.4000
91 C.80000
0 0.0

EH. ATT., DEPTN, & CABLE TENSION

THETA = 2.51 DEG
DELTA = -2.12 DEG

FET CABLE TENSION = C.120030E 03 IES

BR CABLE TENSION = 0.140030E 03 IES

>>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC
-2.9475E-C1 +-5.5731E 00 2.3517E 00
-6.6118E-01 +-8.0081E 00 1.0484E 00
>>>> INTERNAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T E/L-SEC
-1.7860E 00 +-2.7053E 00 3.8811E-C1
-1.4335E 00 +-7.2026E 00 4.8352E-C1
-5.1859E-01 +-9.7303E 00 1.3366E 00

PERIOD-SEC 1/T H/D 1/T H/D
1.1274E 00 4.2523E-C1 4.2523E-C1
7.8460E-01 5.5388E-C1 5.5388E-C1
UNDNAT-CPS DAMP RATIO DECAY RATIO
8.8698E-01 8.8698E-01 8.8698E-01
1.2745E 00 1.2745E 00 1.2745E 00
5.2815E-02 5.2815E-02 5.2815E-02
8.2284E-02 8.2284E-02 8.2284E-02
4.7941E-01 4.7941E-01 4.7941E-01
7.4841E-01 7.4841E-01 7.4841E-01
5.9526E-01 5.9526E-01 5.9526E-01

PERIOD-SEC 1/T H/D 1/T H/D
2.3225E 00 2.3225E 00 2.3225E 00
8.7235E-01 8.7235E-01 8.7235E-01
UNDNAT-CPS DAMP RATIO DECAY RATIO
5.1593E-01 5.1593E-01 5.1593E-01
1.1688E 00 1.1688E 00 1.1688E 00
1.5508E 00 1.5508E 00 1.5508E 00
5.3222E-02 5.3222E-02 5.3222E-02
1.8042E 00 1.8042E 00 1.8042E 00
4.8311E-01 4.8311E-01 4.8311E-01
7.1543E-01 7.1543E-01 7.1543E-01

CASE NO= 1

TEST DATA IRC

FROM CABLE VERTICAL, FROM CABLE HORIZONTAL

NO SKEWERS

PC 1161/AM11-L111 CABLE

INPUT DATA AS SPECIFIED IN AERC ARRAY

AERO (1) = 0.0	AERC (2) = 0.0	AERO (3) = 0.0	AERO (4) = 0.0	AERO (5) = 6.26
AERO (6) = -0.810	AERC (7) = 0.0	AERO (8) = 0.0	AERO (9) = -8.00	AERO (10) = 0.180E-01
AERO (11) = 0.109	AERC (12) = 0.350E-01	AERO (13) = 0.0	AERO (14) = 0.960	AERO (15) = -1.50
AERO (16) = 0.0	AERC (17) = 0.0	AERO (18) = 0.0	AERO (19) = -0.730	AERO (20) = -0.350E-01
AERO (21) = 0.111	AERC (22) = 0.0	AERO (23) = -0.190	AERO (24) = -0.100E-01	AERO (25) = 0.0
AERO (26) = 0.570E-01	AERC (27) = -0.920E-01	AERO (28) = 0.0	AERO (29) = 0.0	AERO (30) = 0.0
AERO (31) = 0.0	AERC (32) = 0.0	AERO (33) = 0.0	AERO (34) = 0.0	AERO (35) = 0.0
AERO (36) = 0.0	AERC (37) = 0.0	AERO (38) = 0.0	AERO (39) = 0.0	AERO (40) = 0.0
AERO (41) = 0.0	AERC (42) = 0.0	AERO (43) = 0.0	AERO (44) = 0.0	AERO (45) = 0.0
AERO (46) = 0.0	AERC (47) = 0.0	AERO (48) = 0.800	AERO (49) = 4.30	AERO (50) = 4.35
AERO (51) = 0.350E-03	AERC (52) = 14.0	AERO (53) = 9.16	AERO (54) = 1.40	AERO (55) = 11.5
AERO (56) = -0.110	AERC (57) = 1.80	AERO (58) = 14.0	AERO (59) = 14.0	AERO (60) = 0.0
AERO (61) = 0.0	AERC (62) = 0.0	AERO (63) = 0.0	AERO (64) = 0.0	AERO (65) = 0.0
AERO (66) = 58.0	AERC (67) = -58.0	AERO (68) = 0.0	AERO (69) = 0.0	AERO (70) = 0.0
AERO (71) = 0.0	AERC (72) = 10.0	AERO (73) = 285.0	AERO (74) = 0.0	AERO (75) = 90.0
AERO (76) = 0.0	AERC (77) = 175.0	AERO (78) = 0.0	AERO (79) = 26.4	AERO (80) = 0.0
AERO (81) = 0.0	AERC (82) = 8.00	AERO (83) = 8.40	AERO (84) = 8.40	AERO (85) = 0.0
AERO (86) = 0.0	AERC (87) = 0.0	AERO (88) = 0.920	AERO (89) = 0.0	AERO (90) = 0.880
AERO (91) = 0.0	AERC (92) = 0.0	AERO (93) = 0.880	AERO (94) = 14.0	AERO (95) = 3.00
AERO (96) = 0.0	AERC (97) = 177.0	AERO (98) = -0.960	AERO (99) = 0.0	AERO (100) = 0.0
AERO (101) = 0.0	AERC (102) = -2.00	AERO (103) = 3.00	AERO (104) = 0.500E-01	AERO (105) = 2.00
AERO (106) = 3.00	AERC (107) = 2.00	AERO (108) = 2.00	AERO (109) = 3.00	AERO (110) = 2.00
AERO (111) = 180.0	AERC (112) = 96.0	AERO (113) = 72.0	AERO (114) = 180.0	AERO (115) = -96.0
AERO (116) = 72.0	AERC (117) = 80.0	AERO (118) = 80.0	AERO (119) = 50.0	AERO (120) = 50.0
AERO (121) = 5.00	AERC (122) = 5.00	AERO (123) = 0.0	AERO (124) = 0.0	AERO (125) = 0.0
AERO (126) = 0.0	AERC (127) = 0.0	AERO (128) = 0.0	AERO (129) = 0.0	AERO (130) = 0.0

>>>> ACT LOCUS VARYING AERO (94)

AERO (94) = 34.000

EF. ATT., DEFLTN, & CABLE TENSION

THETA = 2.20 DEG
DELTA = -0.38 DEG
FRT CAB. TENSION = 0.740171E 02 LBS

>>> LONGITUDINAL STABILITY <<<<
PEAL IMAGINARY T H/D-SEC

	1/T H/D	PERIOD-SEC	DNATF-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-4.1138E-01	5.9300E-01	1.3893E 00	7.1976E-01	7.2273E-01	9.0527E-02	8.2359E-01
-7.6359E-01	1.1016E 00	8.5954E-01	1.1629E 00	1.1692E 00	1.0394E-01	9.4733E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<
REAL IMAGINARY T F/L-SEC

	1/T F/L	PERIOD-SEC	DNATF-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-8.0267E-01	1.1580E 00	1.9508E 00	5.1262E-01	5.2830E-01	2.4181E-01	2.2590E 00
-1.9927E 00	2.8749E 00	1.5618E 00	6.4029E-01	7.1453E-01	4.4386E-01	4.4900E 00
-3.9774E-01	5.7382E-01	7.7017E-01	1.2984E 00	1.3000E 00	4.8657E-02	4.4150E-01

AERO (94) = 93.000

EH. ATT., DEFLTN, & CABLE TENSION

THETA = 2.22 DEG
DELTA = -0.50 DEG
FRT CAB. TENSION = 0.356492E 02 LBS

>>> LONGITUDINAL STABILITY <<<<
PEAL IMAGINARY T H/D-SEC

	1/T H/D	PERIOD-SEC	DNATF-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-4.6201E-01	6.6554E-01	1.3256E 00	7.5438E-01	7.5796E-01	9.7014E-02	8.8358E-01
-7.1231E-01	1.0276E 00	8.2551E-01	1.2114E 00	1.2167E 00	9.3179E-02	8.4833E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<
REAL IMAGINARY T F/L-SEC

	1/T F/L	PERIOD-SEC	DNATF-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-9.1741E-01	1.3235E 00	1.9294E 00	5.1830E-01	5.3847E-01	2.7116E-01	2.5536E 00
-1.8645E 00	2.6859E 00	1.3667E 00	7.3168E-01	7.8956E-01	3.7580E-01	3.6764E 00
-4.1133E-01	5.9342E-01	7.3553E-01	1.3515E 00	1.3531E 00	4.8384E-02	4.3909E-01

AERO (94) = 112.00

EF. ATT., DEFLTN, & CABLE TENSION

THETA = 2.24 DEG
DELTA = -0.61 DEG
FRT CAB. TENSION = 0.672730E 02 LBS

>>> LONGITUDINAL STABILITY <<<<
PEAL IMAGINARY T H/D-SEC

	1/T H/D	PERIOD-SEC	DNATF-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.0694E-01	7.3136E-01	1.2753E 00	7.8411E-01	7.8825E-01	1.0236E-01	9.3272E-01
-6.6702E-01	9.6230E-01	7.9347E-01	1.2603E 00	1.2647E 00	8.3938E-02	7.6354E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<
REAL IMAGINARY T F/L-SEC

	1/T F/L	PERIOD-SEC	DNATF-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-9.5880E-01	1.3833E 00	1.9028E 00	5.2555E-01	5.4726E-01	2.7884E-01	2.6320E 00
-1.8107E 00	2.6123E 00	1.2277E 00	8.1450E-01	8.6358E-01	3.3355E-01	3.2072E 00
-4.2185E-01	6.1148E-01	7.1295E-01	1.4026E 00	1.4043E 00	4.8039E-02	4.3556E-01

AERO (94) = 126.00

EH. ATT., DEFLTN, & CABLE TENSION

THETA = 2.26 DEG
DELTA = -0.73 DEG
FRT CAB. TENSION = 0.109045E 02 LBS

EH. ATT. VELTN. & CABLE TENSION

THETA = 1.35 DEG

DELTA = -1.25 DEG

FRT CBL. TENSION = 0.155741E+03 LBS

RR CBL. TENSION = 0.162035E+03 LBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

	1/T H/D	PERIOD-SEC	DNATF-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-6.4969E-01	+5.6779E-00	1.0601E-00	9.3730E-01	8.9253E-01	1.1508E-01	1.0502E-00
-5.2223E-01	+2.4059E-00	1.3273E-00	7.5341E-01	1.4993E-00	5.5437E-02	5.0329E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

	1/T E/L	PERIOD-SEC	DNATF-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-9.7690E-01	+3.7156E-00	7.0954E-01	1.4034E-00	5.9136E-01	6.1146E-01	2.5428E-01
-1.7402E-00	+7.0930E-00	3.9831E-01	2.5106E-00	1.1289E-00	1.1624E-00	2.3828E-01
-4.7668E-01	+1.0275E-01	1.4541E-00	6.8771E-01	1.6354E-00	1.6371E-00	4.6343E-02

AERC (94) = 196.00

EH. ATT. DEFINT. & CABLE TENSION

THETA = 2.28 DEG

DELTA = -1.40 DEG

FRT CBL. TENSION = 0.167414E+03 LBS

RR CBL. TENSION = 0.196035E+03 LBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC

	1/T H/D	PERIOD-SEC	DNATF-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-6.6675E-01	+5.7162E-00	1.0305E-00	9.6191E-01	9.1602E-01	1.1585E-01	1.0572E-00
-5.0470E-01	+9.6846E-00	1.3734E-00	7.2813E-01	1.5438E-00	5.2034E-02	4.7230E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

	1/T H/D	PERIOD-SEC	DNATF-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-9.7482E-01	+3.8074E-00	7.1105E-01	1.4064E-00	6.0597E-01	2.4803E-01	2.3209E-00
-1.7333E-00	+7.4170E-00	3.9906E-01	2.5002E-00	1.1805E-00	2.2753E-01	2.1180E-00
-4.8606E-01	+1.0545E-01	1.4260E-00	7.0124E-01	1.6800E-00	4.6047E-02	4.1785E-01

CASI

2

TEST DATA UNENRIBED SNUBEEF
FROM CABLE VERTICAL, REAR CABLE HORIZONTAL
SNUBEEPS UNENRIBED
NO LIFT/ANTI-LIFT CABLE

DATA CHANGE

C 0.2

>>>> POST LOCUS VARYING AFEC(94)

AFEC(94) = 94.000

PH. ATT., DEFLECTION, & CABLE TENSION

THETA = 2.26 DEG
DELTA = -0.66 DEG
EPT CAP. TENSION = 0.10811E-01 LBS
EPT CAP. TENSION = 0.86031E-02 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	LNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.025E-01	+8.768E-01	1.3792E-00	7.250E-01	1.149E-00	8.735E-01	8.735E-01	9.156E-02	8.3351E-01
-6.714E-01	+8.234E-00	1.032E-00	9.6814E-01	7.5853E-01	1.3183E-00	1.3227E-00	8.0750E-02	7.3436E-01

>>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-7.771E-01	+4.8442E-00	8.915E-01	1.121E-00	1.297E-00	7.709E-01	7.8083E-01	1.5840E-01	1.4542E-00
-1.290E-00	+8.126E-00	5.3710E-01	1.8618E-00	7.7317E-01	1.2934E-00	1.3096E-00	1.5684E-01	1.4355E-00
-1.125E-00	+9.4515E-00	6.1571E-01	1.6241E-00	6.6478E-01	1.5042E-00	1.5149E-00	1.1827E-01	1.0797E-00

AFEC(94) = 98.000

PH. ATT., DEFLECTION, & CABLE TENSION

THETA = 2.28 DEG
DELTA = -0.60 DEG
EPT CAP. TENSION = 0.12049E-01 LBS
EPT CAP. TENSION = 0.98032E-02 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.411E-01	+8.210E-00	1.281E-00	7.856E-01	1.115E-00	8.929E-01	8.970E-01	9.600E-02	8.742E-01
-6.321E-01	+8.578E-00	1.096E-00	9.120E-01	7.3242E-01	1.3653E-00	1.369E-00	7.3452E-02	6.675E-01

>>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-6.014E-01	+4.9230E-00	8.6491E-01	1.1562E-00	1.2763E-00	7.8352E-01	7.9383E-01	1.606E-01	1.4756E-00
-1.250E-00	+9.402E-00	5.5430E-01	1.8041E-00	7.4779E-01	1.3373E-00	1.3520E-00	1.4720E-01	1.3491E-00
-1.141E-00	+8.746E-00	6.0711E-01	1.6470E-00	6.4466E-01	1.5512E-00	1.5618E-00	1.1633E-01	1.0617E-00

AFEC(94) = 112.00

PH. ATT., DEFLECTION, & CABLE TENSION

THETA = 2.31 DEG
DELTA = -0.63 DEG
EPT CAP. TENSION = 0.132159E-01 LBS
EPT CAP. TENSION = 0.11203E-02 LBS

>>>> LONGITUDINAL STABILITY <<<<

REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-5.737E-01	+8.740E-00	1.270E-00	8.278E-01	1.094E-00	9.130E-01	9.182E-01	9.945E-02	9.055E-01
-5.607E-01	+8.4712E-00	1.1570E-00	8.642E-01	7.0827E-01	1.4115E-00	1.4151E-00	6.7377E-02	6.1214E-01

>>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL	IMAGINARY	T H/D-SEC	1/T H/D	PERIOD-SEC	DNATP-CPS	UNDNAT-CPS	DAMP RATIO	DECAY RATIO
-8.2059E-01	+4.959E-00	8.4470E-01	1.1839E-00	1.2569E-00	7.9561E-01	8.0626E-01	1.6198E-01	1.4880E-00
-1.219E-00	+9.6700E-00	5.6820E-01	1.7600E-00	7.2470E-01	1.3799E-00	1.3935E-00	1.3933E-01	1.2754E-00
-1.1531E-00	+1.0034E-01	6.0112E-01	1.6636E-00	6.2622E-01	1.5969E-00	1.6074E-00	1.1477E-01	1.0418E-00

AFEC(94) = 126.00

PH. ATT., DEFLECTION, & CABLE TENSION

THETA = 2.32 DEG
DELTA = -1.06 DEG
EPT CAP. TENSION = 0.14000E-01 LBS
EPT CAP. TENSION = 0.11203E-02 LBS

```

>>> LONGITUDINAL STABILITY <<<
REAL      IMAGINARY      T F/D-SEC      1/T H/D      PERIOD-SEC      UNDNAT-CPS      DNATF-CPS      DAMP RATIO      DECAT RATIO
-6.014E-01  +5.152E-01  1.152E-01  8.677E-01  1.072E-01  9.376E-01  1.020E-01  9.376E-01  4.77E-01
-5.710E-01  +5.150E-01  1.210E-01  8.237E-01  6.850E-01  1.460E-01  6.221E-01  5.650E-01  5.91E-01
>>> LATERAL/DIRECTIONAL STABILITY <<<
REAL      IMAGINARY      T H/D-SEC      1/T H/D      PERIOD-SEC      UNDNAT-CPS      DNATF-CPS      DAMP RATIO      DECAT RATIO
-8.358E-01  +5.073E-01  8.292E-01  1.205E-01  1.238E-01  8.182E-01  1.625E-01  1.493E-01  3.551E-01
-1.196E-01  +5.929E-01  5.793E-01  1.726E-01  7.036E-01  1.433E-01  1.328E-01  1.214E-01  4.305E-01
-1.161E-01  +5.031E-01  5.566E-01  1.675E-01  6.092E-01  1.651E-01  1.115E-01  1.020E-01  4.928E-01
AERC( 94)= 140.00

```

EH. ATT. DEFLEN. 6 CABLE TENSION

```

THETA = 2.35 DEG
DELTA = -1.20 DEG
FRT CAP. TENSION = 0.155506E 03 LBS
>>> LONGITUDINAL STABILITY <<<
REAL      IMAGINARY      T H/D-SEC      1/T H/D      PERIOD-SEC      UNDNAT-CPS      DNATF-CPS      DAMP RATIO      DECAT RATIO
-6.248E-01  +5.971E-01  1.103E-01  9.016E-01  1.052E-01  9.552E-01  1.006E-01  9.484E-01  5.191E-01
-5.471E-01  +5.043E-01  1.268E-01  7.890E-01  6.653E-01  1.505E-01  5.784E-02  5.252E-01  6.945E-01
>>> LATERAL/DIRECTIONAL STABILITY <<<
REAL      IMAGINARY      T F/D-SEC      1/T F/D      PERIOD-SEC      UNDNAT-CPS      DNATF-CPS      DAMP RATIO      DECAT RATIO
-8.492E-01  +5.145E-01  8.171E-01  1.223E-01  1.221E-01  8.183E-01  1.626E-01  1.494E-01  3.549E-01
-1.178E-01  +5.182E-01  5.811E-01  1.705E-01  6.842E-01  1.473E-01  1.272E-01  1.163E-01  4.464E-01
-1.167E-01  +5.038E-01  5.939E-01  1.683E-01  5.934E-01  1.695E-01  1.095E-01  9.992E-01  5.002E-01
AERC( 94)= 154.00

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EH. ATT. DEFLEN. 6 CABLE TENSION

```

THETA = 2.37 DEG
DELTA = -1.34 DEG
FRT CAP. TENSION = 0.167180E 03 LBS
>>> LONGITUDINAL STABILITY <<<
REAL      IMAGINARY      T F/D-SEC      1/T F/D      PERIOD-SEC      UNDNAT-CPS      DNATF-CPS      DAMP RATIO      DECAT RATIO
-6.407E-01  +5.074E-01  1.075E-01  9.304E-01  1.034E-01  9.725E-01  1.055E-01  9.618E-01  5.132E-01
-5.269E-01  +5.721E-01  1.315E-01  7.600E-01  6.463E-01  1.547E-01  5.413E-02  4.512E-01  7.114E-01
>>> LATERAL/DIRECTIONAL STABILITY <<<
REAL      IMAGINARY      T H/D-SEC      1/T H/D      PERIOD-SEC      UNDNAT-CPS      DNATF-CPS      DAMP RATIO      DECAT RATIO
-8.582E-01  +5.216E-01  8.075E-01  1.238E-01  1.204E-01  8.414E-01  1.623E-01  1.491E-01  3.556E-01
-1.164E-01  +5.427E-01  5.950E-01  1.680E-01  6.665E-01  1.511E-01  1.226E-01  1.120E-01  4.600E-01
-1.170E-01  +5.085E-01  5.920E-01  1.680E-01  5.789E-01  1.737E-01  1.072E-01  9.778E-01  5.077E-01
AERC( 94)= 168.00

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EH. ATT. DEFLEN. 6 CABLE TENSION

```

THETA = 2.40 DEG
DELTA = -1.49 DEG
FRT CAP. TENSION = 0.178853E 03 LBS
FRT CAP. TENSION = 0.16603E 03 LBS
>>> LONGITUDINAL STABILITY <<<
REAL      IMAGINARY      T H/D-SEC      1/T H/D      PERIOD-SEC      UNDNAT-CPS      DNATF-CPS      DAMP RATIO      DECAT RATIO
-6.617E-01  +5.075E-01  1.075E-01  9.304E-01  1.017E-01  9.829E-01  1.065E-01  9.712E-01  5.100E-01
-5.023E-01  +5.999E-01  1.360E-01  7.348E-01  6.287E-01  1.592E-01  5.090E-02  4.620E-01  7.258E-01
>>> LATERAL/DIRECTIONAL STABILITY <<<
REAL      IMAGINARY      T F/D-SEC      1/T F/D      PERIOD-SEC      UNDNAT-CPS      DNATF-CPS      DAMP RATIO      DECAT RATIO
-8.665E-01  +5.287E-01  8.075E-01  1.250E-01  1.184E-01  8.414E-01  1.617E-01  1.485E-01  3.570E-01
-1.154E-01  +5.665E-01  6.004E-01  1.665E-01  6.500E-01  1.549E-01  1.186E-01  1.062E-01  4.721E-01
-1.173E-01  +5.113E-01  5.903E-01  1.692E-01  5.653E-01  1.778E-01  1.049E-01  9.567E-01  5.152E-01
AERC( 94)= 100.00

```

EF. ATT. DEPLTN, 8 CABLE TENSION

IFETA(2.42 DEG

DELTA = -1.65 DEG

REF. CABLE TENSION = 0.190527E 03 LBS

RP CABLE TENSION = 0.182037E 03 LBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D PERIOD-SEC DNATP-CPS UNDNAT-CPS DAMP RATIO DECAY RATIO

-6.7627E-01 +5.2708E 00 1.0250E 01 5.7565E-01 1.0020E 00 9.5903E-01 1.0038E 00 1.0722E-01 9.7758E-01 5.0783E-01

-4.9929E-01 +1.0261E 01 1.4029E 00 7.1311E-01 6.1215E-01 1.6331E 00 1.6350E 00 4.8117E-02 4.3667E-01 7.3884E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D PERIOD-SEC DNATP-CPS UNDNAT-CPS DAMP RATIO DECAY RATIO

-6.7343E-01 +5.3568E 00 7.9359E-01 1.2601E 00 1.1729E 00 8.5250E-01 8.6382E-01 1.6093E-01 1.4782E 00 3.5898E-01

-1.1466E 00 +9.8972E 00 6.0453E-01 1.6542E 00 6.3484E-01 1.5752E 00 1.5857E 00 1.1508E-01 1.0501E 00 4.8292E-01

-1.1741E 00 +1.1369E 01 5.5036E-01 1.6930E 00 5.5267E-01 1.8094E 00 1.8190E 00 1.0273E-01 9.3616E-01 5.2262E-01

AEPC(94) = 156.00

EF. ATT. DEPLTN, 8 CABLE TENSION

IFETA(2.45 DEG

DELTA = -1.81 DEG

REF. CABLE TENSION = 0.202213E 03 LBS

RP CABLE TENSION = 0.196037E 03 LBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D PERIOD-SEC DNATP-CPS UNDNAT-CPS DAMP RATIO DECAY RATIO

-6.8825E-01 +6.3823E 00 1.0562E 01 5.9379E-01 9.8756E-01 1.0126E 00 1.0185E 00 1.0764E-01 9.8143E-01 5.0648E-01

-4.8110E-01 +1.0502E 01 1.4055E 00 6.9421E-01 5.9712E-01 1.6747E 00 1.6764E 00 4.5683E-02 4.1453E-01 7.5026E-01

>>> LATERAL/DIRECTIONAL STABILITY <<<<

REAL IMAGINARY T H/D-SEC 1/T H/D PERIOD-SEC DNATP-CPS UNDNAT-CPS DAMP RATIO DECAY RATIO

-8.7019E-01 +5.4256E 00 7.8839E-01 1.2684E 00 1.1581E 00 8.6351E-01 8.7478E-01 1.5996E-01 1.4689E 00 3.6126E-01

-1.1407E 00 +1.0123E 01 6.0767E-01 1.6456E 00 6.2068E-01 1.6111E 00 1.6213E 00 1.1197E-01 1.0214E 00 4.9260E-01

-1.1744E 00 +1.1610E 01 5.9322E-01 1.6943E 00 5.4075E-01 1.8493E 00 1.8587E 00 1.0056E-01 9.1618E-01 5.2951E-01

CASE(= 3 TEST DATA CHANGE C1 AND C4 ALPHA
FRONT CABLE VERTICAL, REAR CABLE HORIZONTAL
NO SNUBBERES
NO LIFT/ANTI-LIFT CABLE

DATA CHANGE

S 5.5000
6 -1.3000
0 0.0

EF. ATT., DEFLECTION & CABLE TENSION

THETA = 2.94 DEG

DELTA = -2.75 DEG

PRE CAP. TENSION = 0.120742E 03 LBS

RE CAP. TENSION = 0.140053E 03 LBS

>>> LONGITUDINAL STABILITY <<<

REAL IMAGINARY T H/D-SEC

-3.5605E-01 +4.5501E 00 1.7502E 00 5.7138E-01 1.3809E 00 6.2644E-01 1.5902E 00 7.2418E-01 7.2691E-01 8.6714E-02 6.7965E-02 6.1750E-01 5.7874E-01

-6.5065E-01 +9.9917E 00 1.0184E 00 5.8197E-01 6.2644E-01 1.5902E 00 7.2418E-01 7.2691E-01 8.6714E-02 6.7965E-02 6.1750E-01 5.7874E-01

CASE 4 TEST DATA FREQUENCY FULLY HORIZONTAL

FOUR CABLES HORIZONTAL

NO SMOOBERS

AC LEFT/ANTI-LEFT CABLE

DATA CHANGE

5 6.2000

70 6.2

74 82.000

81 26.400

87 8.4000

91 0.8000

0 0.0

EH. ATT. DEFINING CABLE TENSION

THETA = 2.51 DEG

DELTA = -2.12 DEG

FEED CAL. TENSION = 0.120000E 03 IBS

FEED CAL. TENSION = 0.140000E 03 IBS

>>> LONGITUDINAL STABILITY <<<<

REAL IMAGINARY 1/H/D-SEC 1/T H/D

-2.9475E-01 +5.5731E 00 2.3517E 00 4.2523E-01

-6.6118E-01 +8.0001E 00 1.0444E 00 5.5388E-01

>>> INTERVAL/PERIODIC STABILITY <<<<

REAL IMAGINARY T H/D-SFC 1/T F/D

-1.7860E 00 +2.7053E 00 3.8811E-01 2.5766E 00

-1.4335E 00 +7.2026E 00 4.8352E-01 2.0682E 00

-5.1855E-01 +9.7303E 00 1.3366E 00 7.4816E-01

PERIOD-SEC 1.1274E 00 1.1274E 00 7.8460E-01 1.1274E 00

PERIOD-SEC 7.8460E-01 7.8460E-01 1.2745E 00 1.2745E 00

PERIOD-SEC 8.8698E-01 8.8698E-01 1.2745E 00 1.2745E 00

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APPENDIX D

Contained in this Appendix is a program listing. The subroutines as they appear in the listing are itemized below:

EXEC ROUTINE
SUBROUTINE RUTLOC
SUBROUTINE TRANS
SUBROUTINE TRAN1
SUBROUTINE LATSN
SUBROUTINE TRIM
SUBROUTINE EQU
SUBROUTINE FPLYV
SUBROUTINE RPLYH
SUBROUTINE DLGTH
SUBROUTINE DCOSLG
SUBROUTINE LONG
SUBROUTINE PRINTR
SUBROUTINE MASH
SUBROUTINE LAT
SUBROUTINE DCOSD
SUBROUTINE SNTRM
SUBROUTINE LONGSN
SUBROUTINE DRCSN
SUBROUTINE DRCUSN
SUBROUTINE RITE
SUBROUTINE STINT
SUBROUTINE TABIN
SUBROUTINE STINT1
SUBROUTINE TABIN1
SUBROUTINE FRICT
SUBROUTINE FRVT
SUBROUTINE FRHZ
SUBROUTINE MATRIX
SUBROUTINE POLADD
SUBROUTINE POLSUB
SUBROUTINE POLMPY
SUBROUTINE MATMPY
SUBROUTINE TRACE
SUBROUTINE COMPBI

APPENDIX D (CONT.)

SUBROUTINE ENVERT

SUBROUTINE SCALER

SUBROUTINE EQUIL

SUBROUTINE PRBM1

SUBROUTINE PQFB1

SUBROUTINE ENVERT

SUBROUTINE SCALER

SUBROUTINE EQUIL

SUBROUTINE PRBM1

SUBROUTINE PQFB1

C EXEC ROUTINE BEGINS HERE

	COMMON/DAT/AERO(150),AEROP(50),KODE(20),LL	CBL 00010
	COMMON/SNUBH/SNU(3,3),SN(30),THUSN,THLSN,SNUC(3,3)	CBL 00020
	COMMON ZZZ(200)	CBL 00030
	COMMON/TAB1/ZZ(ECC)	CBL 00040
	COMMON/DU/DUM(10,10)	CBL 00050
	DIMENSION TITLE(20),SAVE(50),SAVE1(150)	CBL 00060
	EQUIVALENCE(AERO(1), CDU),(AERO(2), CLC),(AERO(3), CMU),	CBL 00070
1	{AERO(4), CDA),(AERO(5), CLA),(AERO(6), CMA),	CBL 00080
2	{AERO(7), CDQ),(AERO(8), CLG),(AERO(9), CMQ),	CBL 00090
3	{AERO(10), CDO),(AERO(11), CLC),(AERO(12), CMO),	CBL 00100
4	{AERO(13), CDDE),(AERO(14), CLDE),(AERO(15), CMDE),	CBL 00110
5	{AERO(16), CDAD),(AERO(17), CLAC),(AERO(18), CMAD),	CBL 00120
6	{AERO(19), CYB),(AERO(20), CLE),(AERO(21), CNE),	CBL 00130
7	{AERO(22), CYP),(AERO(23), CLF),(AERO(24), CNP),	CBL 00140
8	{AERO(25), CYR),(AERO(26), CLF),(AERO(27), CNR),	CBL 00150
9	{AERO(28), CYDR),(AERO(29), CLDF),(AERO(30), CNDR),	CBL 00160
A	{AERO(31), CYDA),(AERO(32), CLCA),(AERO(33), CNDA),	CBL 00170
B	{AERO(34), CYDS),(AERO(35), CLCS),(AERO(36), CNDS),	CBL 00180
C	{AERO(44), XREF),(AERO(45), ZREF),(AERO(46), XCG),	CBL 00190
D	{AERO(47), ZCG)	CBL 00200
	EQUIVALENCE(AERO (48),AMACH),(AERO (49),VC),(AERO (50), AM)	CBL 00210
	EQUIVALENCE(AERO (51),RHO),(AERO (52), WT),(AERO (53),B)	CBL 00220
	EQUIVALENCE(AERO (54),CBAR),(AERO (55),Sh),(AERO (56), XIXZ)	CBL 00230
	EQUIVALENCE(AERO (57),XIXX),(AERO (58),YIYY),(AERO (59),Z IZZ)	CBL 00240
	EQUIVALENCE(AERO (60),CLT),(AERO (61),CCT),(AERO (62),CMT),	CBL 00250
1	(AERO (63),THE TA)	CBL 00260
	EQUIVALENCE(AERO (66), WLUF),(AERO(67), WLLF),(AERO(68), WLUR),	CBL 00270
1	(AERO (69), WLLR),(AERO(70), WLHF),(AERO(71), WLHR),	CBL 00280
2	(AERO (72), STAF),(AERO(73), STAF),(AERO(74), BLHF),	CBL 00290
3	(AERO (75), BLHR),(AERO(76), WLCF),(AERO(77),STACR),	CBL 00300
4	(AERO (78), BLCR),(AERO(79), EF),(AERO(80), ER),	CBL 00310
5	(AERO (81), AF),(AERO(82), AF),(AERO(83), HUCF),	CBL 00320
6	(AERO (84), HLCF),(AERO(85), HLCF),(AERO(86), HLCR),	CBL 00330
7	(AERO (87), DCF),(AERO(88), CCF),	CBL 00340
8	(AERO (90), RVF),(AERO(91), FHF),(AERO(92), RVR),	CBL 00350
9	(AERO(93), RHR),(AERO(94), TFO),(AERO(95), AKR),	CBL 00360
A	(AERO(96), COU),(AERO(97),S1LTT),(AERO(98),WLLTT),	CBL 00370
B	(AERO(99),TLFTO),(AERO(100),AKLFT),	CBL 00380
C	(AERO(102),ALT1),(AERO(103), ALT2),(AERO(104), CMP)	CBL 00390
	EQUIVALENCE(AERO(105), SNLX),(AERO(106), SNLY),(AERO(107), SNUZ),	CBL 00400
1	(AERO(108), SNLX),(AERO(109), SNLY),(AERO(110), SNLZ),	CBL 00410
2	(AERO(111),SNUST),(AERO(112),SNLWL),(AERO(113),SNUBL),	CBL 00420
3	(AERO(114),SNLST),(AERO(115),SNLWL),(AERO(116),SNLBL),	CBL 00430
4	(AERO(117),TUSNO),(AERO(118),TUSNC),(AERO(119),AKSNU),	CBL 00440
5	(AERO(120),AKSNL),(AERO(121),ACSNU),(AERO(122),ACSNL),	CBL 00450
6	(AERO(123),AKSY),(AERO(124),AKPHI),(AERO(125),AKTHE),	CBL 00460
7	(AERO(126),AKAZ),(AERO(127),T1SY),(AERO(128),T2PHI),	CBL 00470
8	(AERO(129),T3THE),(AERO(130),T4#2)	CBL 00480
	EQUIVALENCE(AEROP(1), CXUP),(AEROP(2), CZLF),(AEROP(3), CMUP),	CBL 00490
1	{AEROP(4), CXAP),(AEROP(5), CZAF),(AEROP(6), CMAP),	CBL 00500
2	{AEROP(7), CXQP),(AEROP(8), CZGF),(AEROP(9), CMQP),	CBL 00510
3	{AEROP(10), CXOP),(AEROP(11), CZCF),(AEROP(12), CMOP),	CBL 00520
4	{AEROP(13),CXDEP),(AEROP(14),CZDEP),(AEROP(15),CMDEP),	CBL 00530
5	{AEROP(16),CXADP),(AEROP(17),CZADP),(AEROP(18),CMADP),	CBL 00540
		CBL 00550

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6      (AEROP(19), CYBP), (AEROP(20), CLEF), (AEROP(21), CNBP), CBL00560
7      (AEROP(22), CYPP), (AEROP(23), CLFF), (AEROP(24), CNPP), CBL00570
      (AEROP(25), CYRP), (AEROP(26), CLFF), (AEROP(27), CNRP), CBL00580
9      (AEROP(28), CYDRP), (AEROP(29), CLDRP), (AEROP(30), CNDRP), CBL00590
A      (AEROP(31), CYDAP), (AEROP(32), CLCAF), (AEROP(33), CNCAP), CBL00600
B      (AEROP(34), CYDSP), (AEROP(35), CLCSF), (AEROP(36), CNDSP), CBL00610
EQUIVALENCE (SN( 1), GX1), (SN( 2), GY1), (SN( 3), GZ1), CBL00620
1      (SN( 4), GX2), (SN( 5), GY2), (SN( 6), GZ2), CBL00630
2      (SN( 7), GX3), (SN( 8), GY3), (SN( 9), GZ3), CBL00640
3      (SN(10), GX4), (SN(11), GY4), (SN(12), GZ4), CBL00650
4      (SN(13), THU), (SN(14), THL), (SN(15), ALU), CBL00660
5      (SN(16), ALL), CBL00670
6      (SN(19), THGX1), (SN(20), THGY1), (SN(21), THGZ1), CBL00680
7      (SN(22), THGX2), (SN(23), THGY2), (SN(24), THGZ2), CBL00690
8      (SN(25), THGX3), (SN(26), THGY3), (SN(27), THGZ3), CBL00700
9      (SN(28), THGX4), (SN(29), THGY4), (SN(30), THGZ4), CBL00710
KASE=0 CBL00720
IR=5 CBL00730
IW=6 CBL00740
L_L=0 CBL00750
DO 11 J=1, 50 CBL00760
11 SAVE(J)=9999. CBL00770
LL=0 CBL00780
READ(IR, 150)(TITLE(I), I=1, 20) CBL00790
READ(IR, 200)(KODE(I), I=1, 16) CBL00800
200 FORMAT(16I5) CBL00810
WRITE(IW, 170) KODE(1), (TITLE(I), I=1, 20) CBL00820
17 FORMAT(1I1, 3X, 'CASE NU=', I3, 4X, 20A4) CBL00830
CALL RITE CBL00840
IF(KODE(7).EQ.1) GO TO 10 CBL00850
READ(IR, 100)(AERO(I), I=1, 36) CBL00860
GO TO 20 CBL00870
10 CALL TABIN(1, 36, NG) CBL00880
IF(NG.EQ.0) GO TO 20 CBL00890
WRITE(IW, 300) NG CBL00900
300 FORMAT(/, ' ERROR IN READING TABLES 1-36, NG=', I2) CBL00910
GO TO 500 CBL00920
20 READ(IR, 100)(AERO(I), I=44, 59) CBL00930
READ(IR, 100)(AERO(I), I=66, 130) CBL00940
100 FORMAT(6E12.5) CBL00950
IF(KODE(12).NE.1) GO TO 32 CBL00960
CALL TABIN(1, 2, NG) CBL00970
IF(NG.EQ.0) GO TO 32 CBL00980
WRITE(IW, 420) NG CBL00990
420 FORMAT(' ERROR IN READING SNUBBER DATA TABLE, NG=', I3) CBL01000
GO TO 500 CBL01010
1000 DO 28 I=1, 150 CBL01020
28 AERO(I)=SAVE1(I) CBL01030
READ(IR, 150)(TITLE(I), I=1, 20) CBL01040
150 FORMAT(20A4) CBL01050
KASE=1 CBL01060
DO 34 J=1, 50 CBL01070
34 SAVE(J)=9999. CBL01080
READ(IR, 200)(KODE(I), I=1, 16) CBL01090
WRITE(IW, 170) KODE(1), (TITLE(I), I=1, 20) CBL01100

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CALL RITE	CBL 01110
WRITE(IW,352)	CBL 01120
31 FORMAT(3X,'DATA CHANGE')	CBL 01130
26 READ(IR,350) K,VALUE	CBL 01140
350 FORMAT(I3,E12.5)	CBL 01150
WRITE(IW,351)K,VALUE	CBL 01160
351 FORMAT(3X,I3,3X,G12.5)	CBL 01170
IF(K.LT.1) GO TO 22	CBL 01180
AERO(K)=VALUE	CBL 01190
IF(K.LT.37) SAVE(K)=AERO(K)	CBL 01200
GO TO 26	CBL 01210
22 LL=0	CBL 01220
32 IF(KODE(7).EQ.0) GO TO 31	CBL 01230
DO 30 I=1,36	CBL 01240
CALL STINT1(AMACH,0,0,I,I,AERO(I),NG)	CBL 01250
IF(NG.NE.0) GO TO 40	CBL 01260
30 CONTINUE	CBL 01270
DO 36 J=1,36	CBL 01280
36 IF(SAVE(J).NE.9999.) AERO(J)=SAVE(J)	CBL 01290
GO TO 31	CBL 01300
40 WRITE(IW,400) I,NG	CBL 01310
400 FORMAT(/, ' ERROR IN TABLE NO ',I4, ' NG= ',I3)	CBL 01320
GO TO 500	CBL 01330
360 FORMAT(6E10.3)	CBL 01340
31 IF(KASE.EQ.1) GO TO 9	CBL 01350
WRITE(IW,801)	CBL 01360
801 FORMAT(5X, 'INPUT DATA AS SPECIFIED IN AERO ARRAY')	CBL 01370
WRITE(IW,800)(I,AERO(I),I=1,130)	CBL 01380
800 FORMAT(5(2X, 'AERO(',I3,')=' ,G10.3))	CBL 01390
9 DO 25 I=1,150	CBL 01400
25 SAVE1(I)=AERO(I)	CBL 01410
IF(KODE(3).EQ.0) GO TO 48	CBL 01420
42 DO 27 I=1,150	CBL 01430
27 AERO(I)=SAVE1(I)	CBL 01440
CALL RUTLOC	CBL 01450
IF(LL.EQ.0) GO TO 1000	CBL 01460
48 CALL TRAN1	CBL 01470
IF(KODE(5).EQ.0) GO TO 49	CBL 01480
WRITE(IW,802)	CBL 01490
802 FORMAT(4X, 'AERO DATA IN STAB. AXIS AT EGLAT. REF. CENTER')	CBL 01500
WRITE(IW,800)(I,AERO(I),I=1,36)	CBL 01510
49 CALL TRIM	CBL 01520
CALL TRANS	CBL 01530
IF(KODE(5).EQ.0) GO TO 50	CBL 01540
WRITE(IW,803)	CBL 01550
803 FORMAT(4X, 'AERO DATA IN BODY AXIS AT EGLAT. REF. CENTER')	CBL 01560
WRITE(IW,804)(I,AEROP(I),I=1,36)	CBL 01570
804 FORMAT(5(2X, 'AEROP(',I3,')=' ,G10.3))	CBL 01580
50 IF(KODE(2)) 70,80,90	CBL 01590
70 WRITE(IW,700)	CBL 01600
700 FORMAT(' ++++ LONGITUDINAL STABILITY ++++')	CBL 01610
CALL LONG	CBL 01620
IF(KODE(3).EQ.1) GO TO 42	CBL 01630
GO TO 1000	CBL 01640
80 WRITE(IW,750)	CBL 01650

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750 FORMAT(' ++++ LATERAL/DIRECTIONAL STABILITY ++++')
      CALL LAT
      IF(KODE(3).EQ.1) GO TO 42
      GO TO 1000
90  WRITE(IW,700)
      CALL LONG
      WRITE(IW,750)
      CALL LAT
      IF(KODE(3).EQ.1) GO TO 42
      GO TO 1000
500 STOP
      END
      SUBROUTINE RUTLOC
      COMMON /DAT/ AERO(150),AEROP(50),KODE(20),LL
      IW=6
      IF(LL.GT.0) GO TO 42
      II=KODE(4)
      VARY= ABS(AERO(II)*.1)
      ANOM= AERO(II)
      L=0
      LL=1
      WRITE(IW,600) II
600  FORMAT(' 1H1.3X,' ROOT LOCUS VARYING AERC(' .I3,')')
42  L=L+1
      II=KODE(4)
      AERO(II)=ANOM-E.*VARY+L*VARY
      IF(L.GT.5) GO TO 44
      WRITE(IW,180) KODE(4),AERO(II)
180  FORMAT('/2X,5HAERO(,I3,2H)=,G12.5)
      RETURN
44  AERO(II)=ANOM
      LL=0
      RETURN
      END
      SUBROUTINE TRANS
C  THIS ROUTINE CALCULATES BODY AXIS AERO DATA AT CR FROM STAB.
C  AXIS AERO DATA AT CR
      COMMON /DAT/ AERO(150),AEROP(50),KODE(20),LL
      EQUIVALENCE(AERO(1), CDU), (AERO(2), CLU), (AERO(3), CMU),
1      (AERO(4), CDA), (AERO(5), CLA), (AERC(6), CMA),
2      (AERO(7), CDQ), (AERO(8), CLQ), (AERO(9), CMQ),
3      (AERO(10), CDD), (AERO(11), CLD), (AERO(12), CMD),
4      (AERO(13), CDDE), (AERO(14), CLDE), (AERO(15), CMDE),
5      (AERO(16), CDD), (AERO(17), CLD), (AERC(18), CMAD),
6      (AERO(19), CYB), (AERO(20), CLE), (AERO(21), CNB),
7      (AERO(22), CYP), (AERO(23), CLF), (AERO(24), CNP),
8      (AERO(25), CYR), (AERO(26), CLF), (AERC(27), CNR),
9      (AERO(28), CYDR), (AERO(29), CLDF), (AERO(30), CNDR),
A      (AERO(31), CYDA), (AERO(32), CLCA), (AERO(33), CNDA),
B      (AERO(34), CYDS), (AERO(35), CLCS), (AERO(36), CNDS),
C      (AERO(44), XREF), (AERO(45), ZFEF), (AERC(46), XCG),
D      (AERO(47), ZCG), (AERO(63), THE1)
      EQUIVALENCE(AEROP(1), CXUP), (AEROP(2), CZUF), (AEROP(3), CMUP),
1      (AEROP(4), CXAP), (AEROP(5), CZAF), (AEROP(6), CMAP),
2      (AEROP(7), CXQP), (AEROP(8), CZCF), (AEROP(9), CMQP),

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CBL 01660

CBL 01670

CBL 01680

CBL 01690

CBL 01700

CBL 01710

CBL 01720

CBL 01730

CBL 01740

CBL 01750

CBL 01760

CBL 01770

CBL 01780

CBL 01790

CBL 01800

CBL 01810

CBL 01820

CBL 01830

CBL 01840

CBL 01850

CBL 01860

CBL 01870

CBL 01880

CBL 01890

CBL 01900

CBL 01910

CBL 01920

CBL 01930

CBL 01940

CBL 01950

CBL 01960

CBL 01970

CBL 01980

CBL 01990

CBL 02000

CBL 02010

CBL 02020

CBL 02030

CBL 02040

CBL 02050

CBL 02060

CBL 02070

CBL 02080

CBL 02090

CBL 02100

CBL 02110

CBL 02120

CBL 02130

CBL 02140

CBL 02150

CBL 02160

CBL 02170

CBL 02180

CBL 02190

CBL 02200


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3      (AEROP(10),CXOP),(AEROP(11),CZCF),(AEROP(12),CMOP), CBL02210
4      (AEROP(13),CXDEP),(AEROP(14),CZDEF),(AEROP(15),CMDEP), CBL02220
5      (AEROP(16),CXADP),(AEROP(17),CZACF),(AEROP(18),CMADP), CBL02230
6      (AEROP(19),CYBP),(AEROP(20),CLEF),(AEROP(21),CNBP), CBL02240
7      (AEROP(22),CYPP),(AEROP(23),CLFF),(AEROP(24),CNPP), CBL02250
8      (AEROP(25),CYRP),(AEROP(26),CLRF),(AEROP(27),CNRP), CBL02260
9      (AEROP(28),CYDRP),(AEROP(29),CLDRP),(AEROP(30),CNDRP), CBL02270
A      (AEROP(31),CYDAP),(AEROP(32),CLDAF),(AEROP(33),CNDAP), CBL02280
B      (AEROP(34),CYDSP),(AEROP(35),CLDSP),(AEROP(36),CNDSP) CBL02290

      IW=6 CBL02300
      ALPHA=THETA CBL02310
      SNALF= SIN(ALPHA) CBL02320
      COALF= COS(ALPHA) CBL02330
      SNSQ = SNALF**2 CBL02340
      COSQ = COALF**2 CBL02350
      SYCD = SNALF*COALF CBL02360
      CDU=CDU+2.*(CDD+CDA*THE TA) CBL02370
      CLU=CLU+2.*(CLD+CLA*THE TA) CBL02380
      CDA=CDA-(CLD+CLA*THE TA) CBL02390
      CLA=CLA+CDD+CDA*THE TA CBL02400
      CXUP=-CLA*SNSQ-CDU*COSQ+(CDA+CLU)*SNCC CBL02410
      CZUP= CDA*SNSQ-CLU*COSQ+(CLA-CDU)*SNCC CBL02420
      CMUP= -CMA *SNALF+ CMU *COALF CBL02430
      CXAP= CLU*SNSQ-CDA*COSQ+(CLA-CDU)*SNCC CBL02440
      CZAP=-CDU*SNSQ-CLA*COSQ-(CDA+CLU)*SNCC CBL02450
      CMAP= CMU *SNALF+ CMA *COALF CBL02460
      CXQP= CLD*SNALF-CDQ*COALF CBL02470
      CZQP=-(CDQ*SNALF+CLQ*COALF) CBL02480
      CMQP= CMQ CBL02490
      CZADP=-CLAD*COALF+CDAD*SNALF CBL02500
      CXADP=-CDAD*COALF-CLAD*SNALF CBL02510
      CMADP= CMAD CBL02520
      CXDEP= CLDE*SNALF-CDDE*COALF CBL02530
      CZDEP=-CDDE*SNALF-CLDE*COALF CBL02540
      CMDEP= CMDE CBL02550
      CYBP= CYB CBL02560
      CNBP= CLB *SNALF+ CNB *COALF CBL02570
      CLBP= -CNB *SNALF+ CLB *COALF CBL02580
      CYPP= (-CYR*SNALF+ CYP*COALF) CBL02590
      CNPP=(-CLR*SNSQ+ CNP*COSQ+ (CLP- CNR)*SNCC) CBL02600
      CLPP=( CNR*SNSQ+ CLP*COSQ- (CLR+ CNF)*SNCC) CBL02610
      CYRP= ( CYP*SNALF+ CYR*COALF) CBL02620
      CNRP=( CLP*SNSQ+ CNR*COSQ+ (CLR+ CNF)*SNCC) CBL02630
      CLRP=(-CNP*SNSQ+ CLR*COSQ+ (CLP- CNF)*SNCC) CBL02640
      CYDAP= CYDA CBL02650
      CNDAP= CLDA*SNALF+ CNDA*COALF CBL02660
      CLDAP= -CNDA*SNALF+ CLDA*COALF CBL02670
      CYDRP= CYDR CBL02680
      CNDRP= CLDR*SNALF+ CNDR*COALF CBL02690
      CLDRP=-CNDR*SNALF+ CLDR*COALF CBL02700
      CYDSP= CYDS CBL02710
      CLDSP=-CND*SNALF+ CLDS*COALF CBL02720
      CNDSP= CLDS*SNALF+ CND*COALF CBL02730
      RETURN CBL02740
      END CBL02750

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SUBROUTINE TRAN1

CBL 02760

C THIS ROUTINE TRANSFORMS INERTIA DATA & STABILITY AXIS AERO DATA

CBL 02770

C THE EQUATION REFERENCE CENTER

CBL 02780

COMMON /DAT/ AERO(150), AEROP(50), KODE(20), LL

CBL 02790

EQUIVALENCE(AERO(1), CDU), (AERO(2), CLU), (AERO(3), CMU),

CBL 02800

1 (AERO(4), CDA), (AERO(5), CLA), (AERO(6), CMA),

CBL 02810

2 (AERO(7), CDQ), (AERO(8), CLQ), (AERO(9), CMQ),

CBL 02820

3 (AERO(10), CDD), (AERO(11), CLD), (AERO(12), CMD),

CBL 02830

4 (AERO(13), CDDE), (AERO(14), CLDE), (AERO(15), CMDE),

CBL 02840

5 (AERO(16), CDAD), (AERO(17), CLAD), (AERO(18), CMAD),

CBL 02850

6 (AERO(19), CYB), (AERO(20), CLB), (AERO(21), CNB),

CBL 02860

7 (AERO(22), CYP), (AERO(23), CLP), (AERO(24), CNP),

CBL 02870

8 (AERO(25), CYR), (AERO(26), CLR), (AERO(27), CNR),

CBL 02880

9 (AERO(28), CYDR), (AERO(29), CLDF), (AERO(30), CNDR),

CBL 02890

A (AERO(31), CYDA), (AERO(32), CLDA), (AERO(33), CNDA),

CBL 02900

B (AERO(34), CYDS), (AERO(35), CLDS), (AERO(36), CNDS),

CBL 02910

C (AERO(44), XREF), (AERO(45), ZREF), (AERO(46), XCG),

CBL 02920

D (AERO(47), ZCG), (AERO(63), THETA)

CBL 02930

EQUIVALENCE(AERO(48), AMACH), (AERO(49), V[), (AERO(50), AM)

CBL 02940

EQUIVALENCE(AERO(51), RHO), (AERO(52), WT), (AERO(53), B)

CBL 02950

EQUIVALENCE(AERO(54), CBAR), (AERO(55), S[), (AERO(56), XIXZ)

CBL 02960

EQUIVALENCE(AERO(57), XIXX), (AERO(58), YIYY), (AERO(59), ZIZZ)

CBL 02970

EQUIVALENCE(AERO(60), CLT), (AERO(61), CDT), (AERO(62), CMT)

CBL 02980

C INERTIA TRANSFORMATIONS

CBL 02990

X=XCG/12.

CBL 03000

Z=ZCG/12.

CBL 03010

XIXX=XIXX+AM*(Z**2)

CBL 03020

YIYY=YIYY+AM*(X**2)+AM*(Z**2)

CBL 03030

ZIZZ=ZIZZ+AM*(X**2)

CBL 03040

XIXZ=XIXZ-AM*X*Z

CBL 03050

C AERO DATA TRANSFORMATIONS

CBL 03060

X=XREF/(12.*CBAR)

CBL 03070

Z=ZREF/(12.*CBAR)

CBL 03080

CMO=CMO-Z*CDQ+X*CLQ

CBL 03090

CMA=CMA-Z*CDA+X*CLA

CBL 03100

CMQ=CMQ-Z*CDQ+X*CLQ

CBL 03110

CMDE=CMDE-Z*CDDE+X*CLDE

CBL 03120

X=XCG/(12.*B)

CBL 03130

Z=ZCG/(12.*B)

CBL 03140

CNB=CNB+X*CYB

CBL 03150

CNR=CNR+X*CYR

CBL 03160

CNP=CNP+X*CYP

CBL 03170

CNDR=CNDR+X*CYDR

CBL 03180

CNDA=CNDA+X*CYDA

CBL 03190

CNDS=CNDS+X*CYDS

CBL 03200

CLR=CLR-Z*CYB

CBL 03210

CLR=CLR-Z*CYR

CBL 03220

CLP=CLP-Z*CYP

CBL 03230

CLDR=CLDR-Z*CYDR

CBL 03240

CLDA=CLDA-Z*CYDA

CBL 03250

CLDS=CLDS-Z*CYDS

CBL 03260

RETURN

CBL 03270

END

CBL 03280

SUBROUTINE LATSN

CBL 03290

COMMON /DAT/ AERO(150), AEROP(50), KODE(20), LL

CBL 03300

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COMMON/SNUBB/SNU(3,3),SN(30),THUSN,THLSN,SNUC(3,3) CBL 03310
COMMON ZZZ(200) CBL 03320
COMMON/DU/DUM(10,10) CBL 03330
COMMON/TAB1/ZZ(200) CBL 03340
EQUIVALENCE(AERO(105),SNLX),(AERO(106),SNLY),(AERO(107),SNUZ), CBL 03350
1(AERO(108),SNLX),(AERO(109),SNLY),(AEFC(110),SNLZ), CBL 03360
2(AERO(111),SNUST),(AERO(112),SNUWL),(AEFC(113),SNUBL), CBL 03370
3(AERO(114),SNLST),(AERO(115),SNLWL),(AEFC(116),SNLBL), CBL 03380
4(AERO(117),TUSNO),(AERO(118),TUSNO),(AEFC(119),AKSNU), CBL 03390
5(AERO(120),AKSNL),(AERO(121),ADSNL),(AEFC(122),ACSNL) CBL 03400
6(AERO(123),THETA),(AERO(124),ADSNL),(AEFC(125),ACSNL) CBL 03410
EQUIVALENCE(SN(1),GX1),(SN(2),GY1),(SN(3),GZ1), CBL 03420
1(SN(4),GX2),(SN(5),GY2),(SN(6),GZ2), CBL 03430
2(SN(7),GX3),(SN(8),GY3),(SN(9),GZ3), CBL 03440
3(SN(10),GX4),(SN(11),GY4),(SN(12),GZ4), CBL 03450
4(SN(13),THU),(SN(14),THL),(SN(15),ALL), CBL 03460
5(SN(16),ALL), CBL 03470
6(SN(19),THGX1),(SN(20),THGY1),(SN(21),THGZ1), CBL 03480
7(SN(22),THGX2),(SN(23),THGY2),(SN(24),THGZ2), CBL 03490
8(SN(25),THGX3),(SN(26),THGY3),(SN(27),THGZ3), CBL 03500
9(SN(28),THGX4),(SN(29),THGY4),(SN(30),THGZ4) CBL 03510
DIMENSION TOPR(3,3),TOPL(3,3),BOTR(3,3),ECTL(3,3) CBL 03520
COT(BBB)=1./TAN(BBB) CBL 03530
GXY(A,AA,C) = (-A*CCT(AA)/C)*12. CBL 03540
GXSX(A,AA,C,D,E,F) = -(A*SIN(AA)+C*D*CCT(E))/F CBL 03550
GXPHI(A,AA,C,D,E,F,G) = (A*AA*COT(C)-C*E*(CCT(F))/G CBL 03560
GYY(A,AA) = (SIN(A)/AA)*12. CBL 03570
GYSX(A,AA,C,D,E,F) = (A*AA*COT(C)+C*SIN(E))/F CBL 03580
GYPHI(A,AA,C,D,E,F) = -(A*SIN(AA)+C*D*(CCT(E))/F CBL 03590
GZY(A,AA,C) = (-A*CCT(AA)/C)*12. CBL 03600
GZSX(A,AA,C,D,E,F,G) = (A*AA*COT(C)-C*E*(CCT(F))/G CBL 03610
GZPHI(A,AA,C,D,E,F) = (A*AA*COT(C)+C*SIN(E))/F CBL 03620
ALY(A) = -A CBL 03630
ALSY(A,AA,C,D) = (A*AA-C*D)/12. CBL 03640
ALPHI(A,AA,C,D) = (A*AA-C*D)/12. CBL 03650
IW=6 CBL 03660
DO 1005 I=1,3 CBL 03670
DO 1005 J=1,3 CBL 03680
SNU(I,J)=0 CBL 03690
1005 SNU(I,J)=0 CBL 03700
DO 1006 I=1,10 CBL 03710
DO 1006 J=1,10 CBL 03720
1006 DUM(I,J)=0 CBL 03730
IF(KODE(10).EQ.0) GO TO 1002 CBL 03740
C TERMS FOR SNUBBER EFFECTS (LAT) CBL 03750
CALL DRCSN(THETA) CBL 03760
IF(KODE(10).EQ.1) CALL DRCLSN(THETA) CBL 03770
DUM(1,2) = -TUSNO*GX1 CBL 03780
DUM(1,3) = TUSNO*GZ1 CBL 03790
DUM(1,5) = -TUSNO*SIN(THGY1) CBL 03800
DUM(1,7) = GY1 CBL 03810
DUM(2,2) = SNLX*TUSNO*GX1/12.+SNLY*TUSNO*GY1/12. CBL 03820
DUM(2,3) = -SNLX*TUSNO*GZ1/12. CBL 03830
DUM(2,4) = -SNLY*TUSNO*SIN(THGX1)/12. CBL 03840
DUM(2,5) = SNLX*TUSNO*SIN(THGY1)/12. CBL 03850

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DUM(2,7) = (-SNUX*GY1+SNUY*GX1)/12. CBL 03860
DUM(3,2) = -SNUZ*TUSNO*GX1/12. CBL 03870
DUM(3,3) = SNUZ*TUSNO*GZ1/12.+SNUY*TUSNO*GY1/12. CBL 03880
DUM(3,5) = -SNUZ*TUSNO*SIN(THGY1)/12. CBL 03890
DUM(3,6) = SNUY*TUSNO*SIN(THGZ1)/12. CBL 03900
DUM(3,7) = (-SNUY*GZ1+SNUZ*GY1)/12. CBL 03910
DUM(4,1) = GXY(GY1,THGX1,ALL) CBL 03920
DUM(4,2) = GXSY(-SNUY,THGX1,-SNUX,GY1,THGX1,ALU) CBL 03930
DUM(4,3) = GXPHI(-SNUZ,GY1,THGX1,-SNUY,GZ1,THGX1,ALU) CBL 03940
DUM(4,4) = -1. CBL 03950
DUM(5,1) = GYY(THGY1,ALL) CBL 03960
DUM(5,2) = GYSY(-SNUY,GX1,THGY1,-SNUX,THGY1,ALU) CBL 03970
DUM(5,3) = GYPHI(-SNUZ,THGY1,-SNUY,GZ1,THGY1,ALU) CBL 03980
DUM(5,5) = -1. CBL 03990
DUM(6,1) = GZY(GY1,THGZ1,ALL) CBL 04000
DUM(6,2) = GZSY(-SNUY,GX1,THGZ1,-SNUX,GY1,THGZ1,ALU) CBL 04010
DUM(6,3) = GZPHI(-SNUZ,GY1,THGZ1,-SNUY,THGZ1,ALU) CBL 04020
DUM(6,6) = -1. CBL 04030
IF(KODE(10).EQ.2) GO TO 1010 CBL 04040
CALL DRC SN(THETA) CBL 04050
Q=.5*RHO*VO*VO CBL 04060
ALU1=ALU+1. CBL 04070
CALL STINT(0,ALU1,0,1,1,TUSN1,NG) CBL 04080
IF(NG.NE.0) GO TO 5000 CBL 04090
ALU2=ALU-1. CBL 04100
CALL STINT(Q,ALU2,0,1,1,TUSN2,NG) CBL 04110
IF(NG.NE.0) GO TO 5000 CBL 04120
GO TO 5001 CBL 04130
5000 WRITE(IW,5002) NG,ALL,ALU,G CBL 04140
5002 FORMAT('ERROR IN SNUBBER TABLE 1,NG=',I2,3'E10.3) CBL 04150
RETURN CBL 04160
5001 CONTINUE CBL 04170
AKTU=(TUSN1-TUSN2)/2. CBL 04180
AKSNU=AKTU CBL 04190
1010 CONTINUE CBL 04200
DUM(7,7) = -1. CBL 04210
DUM(7,8) = AKSNU*12. CBL 04220
DUM(8,1) = ALY(GY1) CBL 04230
DUM(8,2) = ALSY(-SNUY,GX1,-SNUX,GY1) CBL 04240
DUM(8,3) = ALPHI(-SNUZ,GY1,-SNUY,GZ1) CBL 04250
DUM(8,8) = -1. CBL 04260
IF(KODE(10).EQ.1) GO TO 1015 CBL 04270
DO 1016 I=1,3 CBL 04280
DO 1016 J=1,3 CBL 04290
1016 SNUD(I,J)=DUM(I,7)*ADSNU*DUM(8,J)*12. CBL 04300
1015 CALL MASH(3,8) CBL 04310
DO 1050 I=1,3 CBL 04320
DO 1050 J=1,3 CBL 04330
1050 TOPR(I,J)= DUM(I,J) CBL 04340
IF(KODE(10).EQ.1) CALL DRCUSN(THETA) CBL 04350
DUM(1,2) = -TUSNO*GX2 CBL 04360
DUM(1,3) = TUSNO*GZ1 CBL 04370
DUM(1,5) = -TUSNO*SIN(THGY2) CBL 04380
DUM(1,7) = GY2 CBL 04390
DUM(2,2) = SNUX*TUSNO*GX2/12.-SNUY*TUSNO*GY2/12. CBL 04400

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DUM( 2, 3) = -SNUX*TUSNO*GZ2/12. CBL 04410
DUM( 2, 4) = SNUY*TUSNO*SIN( THGX2)/12. CBL 04420
DUM( 2, 5) = SNLX*TUSNO*SIN( THGY2)/12. CBL 04430
DUM( 2, 7) = (-SNUX*GY2-SNLY*GX2)/12. CBL 04440
DUM( 3, 2) = -SNLZ*TUSNO*GX2/12. CBL 04450
DUM( 3, 3) = SNUZ*TUSNO*GZ2/12.-SNUY*TUSNO*GY2/12. CBL 04460
DUM( 3, 5) = -SNLZ*TUSNO*SIN( THGY2)/12. CBL 04470
DUM( 3, 6) = -SNLY*TUSNO*SIN( THGZ2)/12. CBL 04480
DUM( 3, 7) = (SNUY*GZ2+SNUZ*GY2)/12. CBL 04490
DUM( 4, 1) = GXY(GY2, THGX2, ALU) CBL 04500
DUM( 4, 2) = GXSY(SNUY, THGX2, -SNUX, GY2, THGX2, ALU) CBL 04510
DUM( 4, 3) = GXPHI(-SNUZ, GY2, THGX2, SNUY, GZ2, THGX2, ALU) CBL 04520
DUM( 4, 4) = -1. CBL 04530
DUM( 5, 1) = GYY( THGY2, ALU) CBL 04540
DUM( 5, 2) = GYSY(SNUY, GX2, THGY2, -SNUX, THGY2, ALU) CBL 04550
DUM( 5, 3) = GYPHI(-SNUZ, THGY2, SNUY, GZ2, THGY2, ALU) CBL 04560
DUM( 5, 5) = -1. CBL 04570
DUM( 6, 1) = GZY(GY2, THGZ2, ALU) CBL 04580
DUM( 6, 2) = GZSY(SNUY, GX2, THGZ2, -SNUX, GY2, THGZ2, ALU) CBL 04590
DUM( 6, 3) = GZPHI(-SNUZ, GY2, THGZ2, SNUY, THGZ2, ALU) CBL 04600
DUM( 6, 6) = -1. CBL 04610
IF(KODE(10).EQ.2) GO TO 1020 CBL 04620
CALL DRCSN(THETA) CBL 04630
ALU1=ALU+1. CBL 04640
CALL STINT(Q, ALU1, 0, 1, 1, TUSN1, NG) CBL 04650
IF(NG.NE.0) GO TO 5000 CBL 04660
ALU2=ALU-1. CBL 04670
CALL STINT(Q, ALU2, 0, 1, 1, TUSN2, NG) CBL 04680
IF(NG.NE.0) GO TO 5000 CBL 04690
AKTU=(TUSN1-TUSN2)/2. CBL 04700
AKSNU=AKTU CBL 04710
1020 CONTINUE CBL 04720
DUM( 7, 7) = -1. CBL 04730
DUM( 7, 8) = AKSNU*12. CBL 04740
DUM( 8, 1) = ALY(GY2) CBL 04750
DUM( 8, 2) = ALSY(SNUY, GX2, -SNLX, GY2) CBL 04760
DUM( 8, 3) = ALPHI(-SNUZ, GY2, SNUY, GZ2) CBL 04770
DUM( 8, 8) = -1. CBL 04780
IF(KODE(10).EQ.1) GO TO 1025 CBL 04790
DO 1026 I=1,3 CBL 04800
DO 1026 J=1,3 CBL 04810
1026 SNUD(I,J)=SNUD(I,J)+DUM(I,7)*ADSNL*DUM(8,J)*12. CBL 04820
1025 CALL MASH(3,8) CBL 04830
DO 1060 I=1,3 CBL 04840
DO 1060 J=1,3 CBL 04850
1060 TOPL(I,J)=DUM(I,J) CBL 04860
IF(KODE(10).EQ.1) CALL DRCUSN(THETA) CBL 04870
DUM( 1, 2) = -TUSNO*GX3 CBL 04880
DUM( 1, 3) = TUSNO*GZ3 CBL 04890
DUM( 1, 5) = -TUSNO*SIN( THGY3) CBL 04900
DUM( 1, 7) = GY3 CBL 04910
DUM( 2, 2) = SNLX*TUSNO*GX3/12.-SNLY*TUSNO*GY3/12. CBL 04920
DUM( 2, 3) = -SNLX*TUSNO*GZ3/12. CBL 04930
DUM( 2, 4) = SNLY*TUSNO*SIN( THGX3)/12. CBL 04940
DUM( 2, 5) = SNLX*TUSNO*SIN( THGY3)/12. CBL 04950

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	DUM(2, 7) = (- SNLX*GY3- SNLY*GX3)/12.	CBL 04960
	DUM(3, 2) = SNLZ*TL SNO*GX3/12.	CBL 04970
	DJM(3, 3) = - SNLZ*TL SNO*GX3/12.-SNLY*TL SNO*GY3/12.	CBL 04980
	DUM(3, 5) = SNLZ*TL SNO*SIN(THGY3)/12.	CBL 04990
	DUM(3, 6) = - SNLY*TL SNO*SIN(THGZ3)/12.	CBL 05000
	DJM(3, 7) = (SNLY*GX3- SNLZ*GY3)/12.	CBL 05010
	DUM(4, 1) = GXY(GY3, THGX3, ALL)	CBL 05020
	DUM(4, 2) = GXSX(SNLY, THGX3, - SNLX, GY3, THGX3, ALL)	CBL 05030
	DUM(4, 3) = GXPHI(SNLZ, GY3, THGX3, SNLY, GX3, THGX3, ALL)	CBL 05040
	DUM(4, 4) = -1.	CBL 05050
	DUM(5, 1) = GYY(THGY3, ALL)	CBL 05060
	DUM(5, 2) = GYSX(SNLY, GX3, THGY3, - SNLX, THGY3, ALL)	CBL 05070
	DUM(5, 3) = GYPHI(SNLZ, THGY3, SNLY, GX3, THGY3, ALL)	CBL 05080
	DUM(5, 5) = -1.	CBL 05090
	DUM(6, 1) = GZY(GY3, THGZ3, ALL)	CBL 05100
	DUM(6, 2) = GZSX(SNLY, GX3, THGZ3, - SNLX, GY3, THGZ3, ALL)	CBL 05110
	DUM(6, 3) = GZPHI(SNLZ, GY3, THGZ3, SNLY, THGZ3, ALL)	CBL 05120
	DUM(6, 6) = -1.	CBL 05130
	IF(KODE(10).EQ.2) GO TO 1030	CBL 05140
	CALL DRCN(THETA)	CBL 05150
	ALL1=ALL+1.	CBL 05160
	CALL STINT(Q, ALL1, 0, 1, 1, TL SN1, NG)	CBL 05170
	IF(NG.NE.0) GO TO 5000	CBL 05180
	ALL2=ALL-1.	CBL 05190
	CALL STINT(Q, ALL2, 0, 1, 1, TL SN2, NG)	CBL 05200
	IF(NG.NE.0) GO TO 5000	CBL 05210
	AKTL=(TL SN1- TL SN2)/2.	CBL 05220
	AK SNL=AK TL	CBL 05230
1030	CONTINUE	CBL 05240
	DUM(7, 7) = -1.	CBL 05250
	DUM(7, 8) = AKSNL*12.	CBL 05260
	DUM(8, 1) = ALY(GY3)	CBL 05270
	DJM(8, 2) = ALSX(SNLY, GX3, - SNLX, GY3)	CBL 05280
	DJM(8, 3) = ALPHI(SNLZ, GY3, SNLY, GX3)	CBL 05290
	DUM(8, 8) = -1.	CBL 05300
	IF(KODE(10).EQ.1) GO TO 1035	CBL 05310
	DO 1036 I=1,3	CBL 05320
	DO 1036 J=1,3	CBL 05330
1036	SNUD(I, J)=SNUD(I, J)+DUM(I, 7)*ADSNL*DUM(8, 8)*12.	CBL 05340
1035	CALL MASH(3, 8)	CBL 05350
	DO 1070 I=1,3	CBL 05360
	DO 1070 J=1,3	CBL 05370
1070	BOTL(I, J)= DUM(I, J)	CBL 05380
	IF(KODE(10).EQ.1) CALL DRCN(THETA)	CBL 05390
	DUM(1, 2) = - TL SNO*GX4	CBL 05400
	DUM(1, 3) = TL SNO*GX4	CBL 05410
	DUM(1, 5) = - TL SNO*SIN(THGY4)	CBL 05420
	DJM(1, 7) = GY4	CBL 05430
	DJM(2, 2) = SNLX*TL SNO*GX4/12.+SNLY*TL SNO*GY4/12.	CBL 05440
	DJM(2, 3) = - SNLX*TL SNO*GX4/12.	CBL 05450
	DJM(2, 4) = - SNLY*TL SNO*SIN(THGX4)/12.	CBL 05460
	DJM(2, 5) = SNLX*TL SNO*SIN(THGY4)/12.	CBL 05470
	DUM(2, 7) = (- SNLX*GY3+SNLY*GX4)/12.	CBL 05480
	DJM(3, 2) = SNLZ*TL SNO*GX4/12.	CBL 05490
	DUM(3, 3) = - SNLZ*TL SNO*GX4/12.+SNLY*TL SNO*GY4/12.	CBL 05500

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DUM( 3, 5) = SNLZ*TL SNO*SIN( THGY4)/12. CBL 05510
DUM( 3, 6) = SNLY*TL SNO*SIN( THGZ4)/12. CBL 05520
DUM( 3, 7) = (- SNLY*GZ4-SNLZ*GY4)/12. CBL 05530
DUM( 4, 1) = GXY(GY4, THGX4, ALL) CBL 05540
DUM( 4, 2) = GXS(- SNLY, THGX4, -SNLX, GY4, THGX4, ALL) CBL 05550
DUM( 4, 3) = GXPHI( SNLZ, GY4, THGX4, -SNLY, GZ4, THGX4, ALL) CBL 05560
DUM( 4, 4) = -1. CBL 05570
DUM( 5, 1) = GYY( THGY4, ALL) CBL 05580
DUM( 5, 2) = GYS(- SNLY, GX4, THGY4, -SNLX, THGY4, ALL) CBL 05590
DUM( 5, 3) = GYPHI( SNLZ, THGY4, -SNLY, GZ4, THGY4, ALL) CBL 05600
DUM( 5, 5) = -1. CBL 05610
DUM( 6, 1) = GZY(GY4, THGZ4, ALL) CBL 05620
DUM( 6, 2) = GZSY(- SNLY, GX4, THGZ4, -SNLX, GY4, THGZ4, ALL) CBL 05630
DUM( 6, 3) = GZPHI( SNLZ, GY4, THGZ4, -SNLY, THGZ4, ALL) CBL 05640
DUM( 6, 6) = -1. CBL 05650
IF(KODE(10).EQ.2) GO TO 1040 CBL 05660
CALL DRCSN(THETA) CBL 05670
ALL1=ALL+1. CBL 05680
CALL STINT(0, ALL1, 0, 1, 1, TLSN1, NG) CBL 05690
IF(NG.NE.0) GO TO 5000 CBL 05700
ALL2=ALL-1. CBL 05710
CALL STINT(0, ALL2, 0, 1, 1, TLSN2, NG) CBL 05720
IF(NG.NE.0) GO TO 5000 CBL 05730
AKTL=( TLSN1-TLSN2)/2. CBL 05740
AKSNL=AKTL CBL 05750
1040 CONTINUE CBL 05760
DUM( 7, 7) = -1. CBL 05770
DUM( 7, 8) = AKSNL*12. CBL 05780
DUM( 8, 1) = ALY(GY4) CBL 05790
DUM( 8, 2) = ALSY(- SNLY, GX4, -SNLX, GY4) CBL 05800
DUM( 8, 3) = ALPHI( SNLZ, GY4, -SNLY, GZ4) CBL 05810
DUM( 8, 8) = -1. CBL 05820
IF(KODE(10).EQ.1) GO TO 1045 CBL 05830
DO 1046 I=1, 3 CBL 05840
DO 1046 J=1, 3 CBL 05850
1046 SNUD( I, J)=SNUD( I, J)+DUM( I, 7)*ADSNL*DUM( 8, J)*12. CBL 05860
1045 CALL MASH( 3, 8) CBL 05870
DO 1080 I=1, 3 CBL 05880
DO 1080 J=1, 3 CBL 05890
1080 BCTR( I, J)= DUM( I, J) CBL 05900
DO 1090 I=1, 3 CBL 05910
DO 1090 J=1, 3 CBL 05920
1090 SNU( I, J)= TOPR( I, J)+TOPL( I, J)+BCTL( I, J)+E( TR( I, J) CBL 05930
IF(KODE(10).EQ.2) RETURN CBL 05940
DO 1095 I=1, 3 CBL 05950
DO 1095 J=1, 3 CBL 05960
1095 SNUD( I, J)=0 CBL 05970
RETURN CBL 05980
1002 DO 1004 I=1, 3 CBL 05990
DO 1004 J=1, 3 CBL 06000
SNUD( I, J)=0 CBL 06010
1004 SNU( I, J)=0 CBL 06020
RETURN CBL 06030
END CBL 06040
SUBROUTINE TRIM CBL 06050

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C	CABLE SUSPENSION SYSTEM TRIM ROUTINE	CBL 06060
	COMMON /DAT/ AERO(150),AEROP(50),KCDE(20),LL	CBL 06070
	COMMON / PLYCHA/RTD,XLGTH(5),ADC(5,3),AFH(5,3),TR,TLFT,TF	CBL 06080
	DIMENSION ANG(5,3)	CBL 06090
	EQUIVALENCE(AERO(1), CDU),(AERO(2), CLL),(AERO(3), CMU),	CBL 06100
1	(AERO(4), CDA),(AERO(5), CLA),(AERO(6), CMA),	CBL 06110
2	(AERO(7), CDQ),(AERO(8), CLC),(AERO(9), CMQ),	CBL 06120
3	(AERO(10), CDO),(AERO(11), CLC),(AERO(12), CMO),	CBL 06130
4	(AERO(13), CDDE),(AERO(14), CLCE),(AERO(15), CMDE),	CBL 06140
5	(AERO(16), CDAD),(AERO(17),CLAC),(AERO(18),CMAD),	CBL 06150
6	(AERO(19), CYB),(AERO(20), CLE),(AERO(21), CNB),	CBL 06160
7	(AERO(22), CYP),(AERO(23), CLF),(AERO(24), CNP),	CBL 06170
8	(AERO(25), CYR),(AERO(26), CLF),(AERO(27), CNR),	CBL 06180
9	(AERO(28), CYDR),(AERO(29), CLCF),(AERO(30), CNDR),	CBL 06190
A	(AERO(31), CYDA),(AERO(32), CLCA),(AERO(33), CNDA),	CBL 06200
B	(AERO(34), CYDS),(AERO(35), CLCS),(AERO(36), CNDS)	CBL 06210
	EQUIVALENCE(AERO(46),XCG),(AERO(47),ZCG)	CBL 06220
	EQUIVALENCE(AERO (48),AMACH),(AERO (49),VC),(AERO (50), AM)	CBL 06230
	EQUIVALENCE(AERO (51),RHO),(AERO (52), WT),(AERO (53),B)	CBL 06240
	EQUIVALENCE(AERO (54),CBAR),(AERO (55),SH),(AERO (56), XIXZ)	CBL 06250
	EQUIVALENCE(AERO (57),XIXX),(AERO (58),YIYY),(AERO (59),Z IZZ)	CBL 06260
	EQUIVALENCE(AERO (60),CLT),(AERO (61),CET),(AERO (62),CMT),	CBL 06270
	1(AERO(63),THE TA)	CBL 06280
	EQUIVALENCE(AERO (66), WLCF),(AERO(67), WLLF),(AERO(68), WLUR),	CBL 06290
1	(AERO (69), WLLR),(AERO(70), WLFH),(AERO(71), WLHR),	CBL 06300
2	(AERO (72), STAF),(AERO(73), STAR),(AERO(74), BLHF),	CBL 06310
3	(AERO (75), BLHR),(AERO(76), WLCF),(AERO(77),STACR),	CBL 06320
4	(AERO (78), BLCR),(AERO(79), EF),(AERO(80), ER),	CBL 06330
5	(AERO (81), AF),(AERO(82), AF),(AERO(83), HUCF),	CBL 06340
6	(AERO (84), HLCF),(AERO(85), HLCF),(AERO(86), HLCR),	CBL 06350
7	(AERO (87), DCF),(AERO(88), DCR),(AERO(89), ALF),	CBL 06360
8	(AERO (90), RVF),(AERO(91), FHF),(AERO(92), RVR),	CBL 06370
9	(AERO(93), RHR),(AERO(94), TFO),(AERO(95), AKR),	CBL 06380
A	(AERO(96), ALRC),(AERO(97),STLTT),(AERO(98),WLLTT),	CBL 06390
B	(AERO(99),TLFTO),(AERO(100),AKLFT),(AERO(101),ALLTO),	CBL 06400
C	(AERO(102),ALT X),(AERO(103),ALT Z)	CBL 06410
	EQUIVALENCE(AEROP(1), CXLP),(AEROP(2), CZLF),(AEROP(3), CMUP),	CBL 06420
1	(AEROP(4), CXAP),(AEROP(5), CZAF),(AEROP(6), CMAP),	CBL 06430
2	(AEROP(7), CXQP),(AEROP(8), CZCF),(AEROP(9), CMQP),	CBL 06440
3	(AEROP(10), CXOP),(AEROP(11), CZCF),(AEROP(12), CMOP),	CBL 06450
4	(AEROP(13),CXDEP),(AEROP(14),CZDEF),(AEROP(15),CMDEP),	CBL 06460
5	(AEROP(16),CXADP),(AEROP(17),CZADF),(AEROP(18),CMADP),	CBL 06470
6	(AEROP(19), CYBP),(AEROP(20), CLEF),(AEROP(21), CNBP),	CBL 06480
7	(AEROP(22), CYPP),(AEROP(23), CLFF),(AEROP(24), CNPP),	CBL 06490
8	(AEROP(25), CYRP),(AEROP(26), CLFF),(AEROP(27), CNRP),	CBL 06500
9	(AEROP(28),CYDRP),(AEROP(29),CLCFP),(AEROP(30),CNDRP),	CBL 06510
A	(AEROP(31),CYDAP),(AEROP(32),CLCAF),(AEROP(33),CNDAP),	CBL 06520
B	(AEROP(34),CYDSP),(AEROP(35),CLCSF),(AEROP(36),CNDSP)	CBL 06530
	RTD=57.295E	CBL 06540
	THETA=C.	CBL 06550
	DELALF=.001	CBL 06560
	DTF=.1	CBL 06570
	DALFAW=0.0	CBL 06580
	DDELTE=0.0	CBL 06590
	DTIRST=0.0	CBL 06600

ICNTR=0	CBL 06610
FIRST=C.	CBL 06620
THINT=C.	CBL 06630
ALFINT=THETA	CBL 06640
DELINT=0.	CBL 06650
THRSTO=THINT	CBL 06660
ALFAWO=ALFINT	CBL 06670
DELTEO=DELINT	CBL 06680
QS=RHO*VO*VO*.5*SW	CBL 06690
209 THRSTI=THRSTO+DTHRST	CBL 06700
ALFAWI=ALFAWO+DALFAW	CBL 06710
DELTEI=DELTEO+DDELTE	CBL 06720
ICNTR=ICNTR+1	CBL 06730
IF(ICNTR.GT.100)GO TO 520	CBL 06740
VAL1=ALFAWI*RTD	CBL 06750
VAL2=DELTEI*RTD	CBL 06760
VAL3=THRSTI	CBL 06770
CALL EQU(ALFAWI,DELTEI,THRSTI,F0,G0,H0,HC,FIRST)	CBL 06780
IF(FIRST.NE.1.)FIRST=1.	CBL 06790
C COMPUTES PARTIALS	CBL 06800
ALFAWI=ALFAWI+DELALF*0.5	CBL 06810
CALL EQU(ALFAWI,DELTEI,THRSTI,F1,G1,H1,1.)	CBL 06820
ALFAWI=ALFAWI-DELALF	CBL 06830
CALL EQU(ALFAWI,DELTEI,THRSTI,F2,G2,H2,1.)	CBL 06840
ALFAWI=ALFAWI+DELALF*0.5	CBL 06850
FALFWO=(F1-F2)/DELALF	CBL 06860
GALFWO=(G1-G2)/DELALF	CBL 06870
HALFWO=(H1-H2)/DELALF	CBL 06880
FDELEO=-QS*(CLDE*COS(ALFAWI)+CODE*SIN(ALFAWI))	CBL 06890
GDELEO=QS*(CLDE*SIN(ALFAWI)-CODE*COS(ALFAWI))	CBL 06900
HDELEO=QS*CBAR*CMDE	CBL 06910
THRSTI=THRSTI+DTF	CBL 06920
CALL EQU(ALFAWI,DELTEI,THRSTI,F1,G1,H1,1.)	CBL 06930
THRSTI=THRSTI-2.*DTF	CBL 06940
CALL EQU(ALFAWI,DELTEI,THRSTI,F2,G2,H2,1.)	CBL 06950
THRSTI=THRSTI+DTF	CBL 06960
FTHSTO=(F1-F2)/DTF	CBL 06970
GTHSTO=(G1-G2)/DTF	CBL 06980
HTHSTO=(H1-H2)/DTF	CBL 06990
C SET UP ITERATION EQUATIONS	CBL 07000
FI=F0+FALFWO*DALFAW+FDELEO*DDELTE+FTHSTC*CTHRST	CBL 07010
GI=G0+GALFWO*DALFAW+GDELEO*DDELTE+GTHSTC*CTHRST	CBL 07020
HI=H0+HALFWO*DALFAW+HDELEO*DDELTE+HTHSTC*CTHRST	CBL 07030
ACCZ=FI/AM	CBL 07040
ACCX=GI/AM	CBL 07050
THEDOT=HI/YIYY	CBL 07060
IF(ABS(ACCZ).LT..01)GO TO 1005	CBL 07070
GO TO 1100	CBL 07080
1005 IF(ABS(ACCX).LT..01)GO TO 1007	CBL 07090
GO TO 1100	CBL 07100
1007 IF(ABS(THEDOT).LE.0.001)GO TO 42	CBL 07110
C NOW COMPUTE PARAMETER INCREMENTS FROM MATRIX EQUATIONS	CBL 07120
1100 DETRM=FALFWO*GDELEO*HTHSTO+FDELEO*GTHSTC+HALFWO*FTHSTO+GALFWO*	CBL 07130
1HDELEO-FTHSTO*GDELEO*HALFWO-FALFWO*GTHSTC+HDELEO-FDELEO*GALFWO*	CBL 07140
2HTHSTO	CBL 07150

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DALFAW=(-(GDELEO*HTHSTO-GTHSTO*HDELEO)*FC+(FDELEO*HTHSTO-FTHSTO
1*HDELEO)*GO-(FDELEO*GTHSTO-FTHSTO*GDELEO)*HC)/DETRM CBL 07160
DDELTE=(+(GALFWO*HTHSTO-GTHSTO*HALFWO)*FC-(FALFWO*HTHSTO-HALFWO
1*FTHSTO)*GO+(FALFWO*GTHSTO-FTHSTO*GALFWO)*HC)/DETRM CBL 07170
DTHRST=(-(GALFWO*HDELEO-GDELEC*HALFWO)*FC+(FALFWO*HDELEO-FDELEO
1*HALFWO)*GO-(FALFWO*GDELEO-FDELEO*GALFWO)*HC)/DETRM CBL 07180
THRSTO=THRSTI CBL 07190
ALFAWO=ALFAWI CBL 07200
DELTEO=DELTEI CBL 07210
GO TO 209 CBL 07220
520 WRITE(6,521) CBL 07230
521 FORMAT(' TRIM ITERATION EXCEEDS LIMITS') CBL 07240
GO TO 522 CBL 07250
42 CALL EQU(ALFAWI,DELTEI,THRSTI,FC,GC,HC,1.) CBL 07260
522 DO 523 IZZ=1,4 CBL 07270
DO 523 IZK=1,3 CBL 07280
ANG(IZZ,IZK)=ADC(IZZ,IZK)*RTD CBL 07290
523 CONTINUE CBL 07300
THETA=ALFAWI CBL 07310
DE=DELTEI CBL 07320
TF=THRSTI CBL 07330
THETC=THETA*RTD CBL 07340
DED=DE*RTD CBL 07350
DO 524 IZZ=1,4 CBL 07360
IF(KODE(5).EQ.0) GO TO 526 CBL 07370
WRITE(6,525) IZZ,XLGTH(IZZ),(ANG(IZZ,IZK),AFN(IZZ,IZK),IZK=1,3) CBL 07380
525 FORMAT(' CABLE GEOMETRY-CABLE NO.',I2,5),' CAELE LENGTH=',E15.6, CBL 07390
1' IN',/,3X,' DIR. COS.=DEG ARM-IN',/,(3(3X,2E15.6,/)),//) CBL 07400
524 CONTINUE CBL 07410
WRITE(6,526) ICNTR,ACC2,ACCX,THEDGT CBL 07420
526 FORMAT(' ITERATION PARAMETER =',I5,/,2X,' ACC2 =',E15.8, CBL 07430
1/, 2X,' ACCX =',E15.8,/,2X,' THEDGT=',E15.8,' FAC/SEC') CBL 07440
528 WRITE(6,527) THETD,DED,TF,TP CBL 07450
527 FORMAT(/, 'VEH. ATT.,DEFLT, & CABLE TENSION',/, CBL 07460
12X,' THETA =',F6.2,' DEG',/,2X,' DELTA =',F6.2,' DEG',/,2X CBL 07470
2,' FRT CAB. TENSION=',E15.6,' LBS',/, CBL 07480
32X,' RR CAB. TENSION =',E15.6,' LBS') CBL 07490
RETURN CBL 07500
END CBL 07510
SUBROUTINE EQU(THETA,DE,TF,FF,GG,HH,FIRST) CBL 07520
CABLE SUSPENSION SYSTEM TRIM EQUATIONS CBL 07530
COMMON /DAT/ AERO(150),AEROP(50),KODE(20),LL CBL 07540
COMMON / PLYCHA/RTD,XLGTH(5),ADC(5,3),AFN(5,3),TR,TLFT,DUMMY CBL 07550
REAL*8 XNM1,XNM2,YNM1,YNM2 CBL 07560
EQUIVALENCE(AERO(1),CDL),(AERO(2),CLL),(AERO(3),CMU), CBL 07570
1 (AERO(4),CDA),(AERO(5),CLA),(AERO(6),CMA), CBL 07580
2 (AERO(7),CDQ),(AERO(8),CLQ),(AERO(9),CMQ), CBL 07590
3 (AERO(10),CDO),(AERO(11),CLC),(AERO(12),CMC), CBL 07600
4 (AERO(13),CDDE),(AERO(14),CLCE),(AERO(15),CMDE), CBL 07610
5 (AERO(16),CDAD),(AERO(17),CLAC),(AERO(18),CMAD), CBL 07620
6 (AERO(19),CYB),(AERO(20),CLE),(AERO(21),CNB), CBL 07630
7 (AERO(22),CYP),(AERO(23),CLF),(AERO(24),CNP), CBL 07640
8 (AERO(25),CYR),(AERO(26),CLF),(AERO(27),CNR), CBL 07650
9 (AERO(28),CYDR),(AERO(29),CLCF),(AERO(30),CNDR), CBL 07660
A (AERO(31),CYDA),(AERO(32),CLCA),(AERO(33),CNDA). CBL 07670

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B	(AERO(34), CYDS), (AERO(35), CLCS), (AERO(36), CNDS)	CBL 07710
	EQUIVALENCE(AERO(46), XCG), (AERO(47), ZCG)	CBL 07720
	EQUIVALENCE(AERO(48), AMACH), (AERO(49), VC), (AERO(50), AM)	CBL 07730
	EQUIVALENCE(AERO(51), RHO), (AERO(52), WT), (AERO(53), B)	CBL 07740
	EQUIVALENCE(AERO(54), CBAR), (AERO(55), SV), (AERO(56), XIXZ)	CBL 07750
	EQUIVALENCE(AERO(57), XIXX), (AERO(58), YIYY), (AERO(59), ZIZZ)	CBL 07760
	EQUIVALENCE(AERO(60), CLT), (AERO(61), CCT), (AERO(62), CMT)	CBL 07770
	EQUIVALENCE(AERO(66), WLUF), (AERO(67), WLLF), (AERO(68), WLUR),	CBL 07780
1	(AERO(69), WLLR), (AERO(70), WLHF), (AERO(71), WLHR),	CBL 07790
2	(AERO(72), STAF), (AERO(73), STAF), (AERO(74), BLHF),	CBL 07800
3	(AERO(75), BLHR), (AERO(76), WLCF), (AERO(77), STACR),	CBL 07810
4	(AERO(78), BLCR), (AERO(79), EF), (AERO(80), ER),	CBL 07820
5	(AERO(81), AF), (AERO(82), AR), (AERO(83), HUCF),	CBL 07830
6	(AERO(84), HLCF), (AERO(85), HLCF), (AERO(86), HLCR),	CBL 07840
7	(AERO(87), DCF), (AERO(88), DCF), (AERO(89), ALF),	CBL 07850
8	(AERO(90), RVF), (AERO(91), FHF), (AERO(92), RVR),	CBL 07860
9	(AERO(93), RHR), (AERO(94), TFO), (AERO(95), AKR),	CBL 07870
A	(AERO(96), ALR0), (AERO(97), STLTT), (AERO(98), WLLTT),	CBL 07880
B	(AERO(99), TLFT0), (AERO(100), AKLFT), (AERO(101), ALLT0),	CBL 07890
C	(AERO(102), ALT1), (AERO(103), ALT2)	CBL 07900
	DATA XNM1, XNM2 /'VERTICAL', 'HCRIZNTL' /	CBL 07910
	RTD=57.25EE	CBL 07920
	VAL1=THETA	CBL 07930
	Q = RHO*VO*VO/2.0	CBL 07940
64	IND=KODE(6)	CBL 07950
	GO TO (501, 502, 503, 504), IND	CBL 07960
501	YNM1=XNM1	CBL 07970
	YNM2=XNM2	CBL 07980
	CALL FPLYV(STAF, WLUF, WLLF, HUCF, HLCF, EF, FVF, THETA, 1)	CBL 07990
	CALL RPLYH(STAR, BLHR, WLHR, -AR, DCR, 0., RHF, THETA, 3)	CBL 08000
	GO TO 505	CBL 08010
502	YNM1=XNM2	CBL 08020
	YNM2=XNM1	CBL 08030
	CALL RPLYH(STAF, BLHF, WLHF, AF, DCF, 0., RHF, THETA, 1)	CBL 08040
	CALL FPLYV(STAR, WLUR, WLLR, HUCR, HLCR, ER, FVF, THETA, 3)	CBL 08050
	GO TO 505	CBL 08060
503	YNM1=XNM1	CBL 08070
	YNM2=XNM1	CBL 08080
	CALL FPLYV(STAF, WLUF, WLLF, HUCF, HLCF, EF, FVF, THETA, 1)	CBL 08090
	CALL FPLYV(STAR, WLUR, WLLR, HUCR, HLCR, ER, FVF, THETA, 3)	CBL 08100
	GO TO 505	CBL 08110
504	YNM1=XNM2	CBL 08120
	YNM2=XNM2	CBL 08130
	CALL RPLYH(STAF, BLHF, WLHF, AF, DCF, 0., RHF, THETA, 1)	CBL 08140
	CALL RPLYH(STAR, BLHR, WLHR, -AR, DCR, 0., RHF, THETA, 3)	CBL 08150
505	IF(KODE(11)) 506, 507, 506	CBL 08160
506	WLLT = WLCR + ALTZ*SIN(THETA) - ALTZ*CCS(THETA)	CBL 08170
	STALT = STACR - ALTZ*COS(THETA) - ALTZ*SIN(THETA)	CBL 08180
	XLGTH(5) = SQRT((WLLT - WLLT)**2 + (STLT - STALT)**2)	CBL 08190
	IF(FIRST.NE.0.) GO TO 12	CBL 08200
	ELL0=XLGTH(5)	CBL 08210
12	FLL=XLGTH(5)	CBL 08220
	T_FT = TLFT0+AKLFT*(ELL-ELL0)	CBL 08230
	ARM(5, 1)=ALT1	CBL 08240
	ARM(5, 2)=C	CBL 08250

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      ARM(5,3)=ALTZ                                CBL 08260
      FXLTT = (TLFT*(STALT - STLTT))/XLGTH(5)      CBL 08270
      FZLTT = (TLFT*(WLLT - WLLTT))/XLGTH(5)      CBL 08280
      FXLTB = FXLTT*COS(THETA) - FZLTT*SIN(THETA)  CBL 08290
      FZLTB = FZLTT*COS(THETA) + FXLTT*SIN(THETA) CBL 08300
      YMLFT =( FXLTB*ALTZ - FZLTB*ALTZ)/12.        CBL 08310
      ADC(5,1)=ARCOS(FXLTB/TLFT)                   CBL 08320
      ADC(5,2)=3.14159/2.                          CBL 08330
      ADC(5,3)=ARCOS(FZLTB/TLFT)                   CBL 08340
      GO TO 506                                     CBL 08350
507 FXLTB=0.                                       CBL 08360
      FZLTB=0.                                       CBL 08370
      YMLFT=0.                                       CBL 08380
      TLFT=0                                         CBL 08390
      XLGTH(5)=0.                                    CBL 08400
      DO 13 IA=1,3                                  CBL 08410
      ARM(5,IA)=0.                                   CBL 08420
      ADC(5,IA)=0.                                   CBL 08430
13 CONTINUE                                       CBL 08440
508 CALL SNTRM(FXSN,FZSN,EMSN,THETA)              CBL 08450
      IF (FIRST.NE.0.)GO TO 510                    CBL 08460
      IF(KODE(5).EQ.C) GO TO 512                   CBL 08470
      WRITE(6,509)YNM1,YNM2                        CBL 08480
509 FORMAT(' CABLE CONFIGURATION CN MODEL',/,      CBL 08490
1' FRONT CABLE IS ',A8,' AND REAR CABLE IS ',A8)  CBL 08500
512 EL0=XLGTH(3)+XLGTH(4)                          CBL 08510
510 EL=XLGTH(3)+XLGTH(4)                          CBL 08520
      TR=TR0+AKR*(EL-EL0)                          CBL 08530
      ELIFT=Q*SW*(CLO+CLA*THE TA+CLDE*DE)          CBL 08540
      ADRAG=Q*SW*(CDO+COA*THE TA+CDDE*DE)          CBL 08550
      FXAIR=-ADRAG*COS(THETA)+ELIFT*SIN(THETA)     CBL 08560
      FZAIR=-ADRAG*SIN(THETA)-ELIFT*COS(THETA)     CBL 08570
      WGTX=-32.2*AM*SIN(THETA)                     CBL 08580
      WGTZ=32.2*AM*COS(THETA)                      CBL 08590
      EMWGT=(ZCG*WGTX-XCG*WGTZ)/12.                CBL 08600
      FXCR=TR*(COS(ADC(3,1))+COS(ADC(4,1)))         CBL 08610
      FZCR=TR*(COS(ADC(3,3))+COS(ADC(4,3)))         CBL 08620
      FXCF=TF*(COS(ADC(1,1))+COS(ADC(2,1)))         CBL 08630
      FZCF=TF*(COS(ADC(1,3))+COS(ADC(2,3)))         CBL 08640
      EMOC=0.                                        CBL 08650
      DO 511 I=1,4                                  CBL 08660
      TENS=TF                                         CBL 08670
      IF (I.GT.2) TENS=TR                          CBL 08680
      FMOC=EMOC+TENS*(COS(ADC(I,1))*ARM(I,3)-COS(ADC(I,3))*ARM(I,1)) CBL 08690
511 CONTINUE                                       CBL 08700
      EMOC=EMOC/12.                                 CBL 08710
      AEROM=Q*SW*CBAR*(CMO+CMA*THE TA+CMDE*DE)     CBL 08720
      FF=FZCF+FZCR+FZLTB+FZSN+WGTZ+FXAIR          CBL 08730
      GG=FXCF+FXCR+FXLTB+FXSN+WGTX+FXAIR          CBL 08740
      HH=EMOC+YMLFT+EMSN+EMWGT+AEROM               CBL 08750
      RETURN                                         CBL 08760
      END                                           CBL 08770
      SUBROUTINE FPLYV(STAV,WLU,WLL,HHU,HHL,EF,FAC,THETA,IF) CBL 08780
      COMMON /DAT/AERO(150),AEROP(50),KODE(20),LL   CBL 08790
      COMMON /PL YCHA/RTD,XLGTH(5),ADC(5,3),ARM(5,3),TF,TLFT,TF CBL 08800

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EQUIVAFNCE (AERO(76),WLCR),(AERO(77),STACF),(AERC(78),BLCR)	CBL 08810
PI=3.14159	CBL 08820
GAMU= ATAN(HHL/EP)	CBL 08830
T1= EP*EP +FHU*HHU	CBL 08840
T2= THETA +GAMU	CBL 08850
IF(IF.EQ.3) T2=GAMU-THETA	CBL 08860
WLUC= WLCR +SQRT(T1)*SIN(T2)	CBL 08870
T3= WLU -WLUC	CBL 08880
T4= ABS(STACR -STAV) -SQRT(T1)*COS(T2)	CBL 08890
XLUP= SQRT(T3*T3+T4*T4)	CBL 08900
XLU= SQRT(XLUP*XLUP -RAD*RAD)	CBL 08910
BUP= ATAN(T3/T4)	CBL 08920
DBU= ATAN(RAD/XLL)	CBL 08930
BETAU=(BUP -DBU)*RTD	CBL 08940
GAML= ATAN(HHL/EP)	CBL 08950
T5= EP*EP +FHL*HHL	CBL 08960
T6= THETA -GAML	CBL 08970
IF(IF.EQ.3) T6=-(THETA+GAML)	CBL 08980
WLLC= WLCR +SQRT(T5)*SIN(T6)	CBL 08990
T7= WLLC -WLL	CBL 09000
T8= ABS(STACR -STAV) -SQRT(T5)*COS(T6)	CBL 09010
XLLP= SQRT(T7*T7 +T8*T8)	CBL 09020
XLL= SQRT(XLLP*XLLP -RAD*RAD)	CBL 09030
BLP= ATAN(T7/T8)	CBL 09040
DBL= ATAN(RAD/XLL)	CBL 09050
BETAL= (BLP -DBL)*RTD	CBL 09060
IF(IF.EQ.1)GO TO 1	CBL 09070
XLGTH(3)=XLU	CBL 09080
XLGTH(4)=XLL	CBL 09090
ADC(3,1)=BETAU/RTD- THE TA+PI	CBL 09100
ADC(3,2)=-PI/2.	CBL 09110
ADC(3,3)=PI/2.-ADC(3,1)	CBL 09120
ADC(4,1)=PI-(BETAL/RTD- THE TA)	CBL 09130
ADC(4,2)=-PI/2	CBL 09140
ADC(4,3)=PI/2-ADC(4,1)	CBL 09150
ARM(3,1)=-EP+RAD*SIN(ADC(3,1))	CBL 09160
ARM(3,2)=0.	CBL 09170
ARM(3,3)=-FHU+RAD*COS(ADC(3,1))	CBL 09180
ARM(4,1)=-EP-RAD*SIN(ADC(4,1))	CBL 09190
ARM(4,2)=0.	CBL 09200
ARM(4,3)=HHL-RAD*COS(ADC(4,1))	CBL 09210
RETURN	CBL 09220
1 XLGTH(1)=XLU	CBL 09230
XLGTH(2)=XLL	CBL 09240
ADC(1,1)=-BETAL/RTD+THE TA	CBL 09250
ADC(1,2)=PI/2.	CBL 09260
ADC(1,3)=PI/2.-ADC(1,1)	CBL 09270
ADC(2,1)=BETAL/RTD+THE TA	CBL 09280
ADC(2,2)=PI/2.	CBL 09290
ADC(2,3)=PI/2.-ADC(2,1)	CBL 09300
ARM(1,1)=EP+RAD*SIN(ADC(1,1))	CBL 09310
ARM(1,2)=0.	CBL 09320
ARM(1,3)=-FHU-RAD*COS(ADC(1,1))	CBL 09330
ARM(2,1)=EP-RAD*SIN(ADC(2,1))	CBL 09340
ARM(2,2)=0.	CBL 09350

ARM(2, 3)=HML +RAD*CO S(ADC(2,1))	CBL 09360
RETURN	CBL 09370
END	CBL 09380
SUBROUTINE RPLYH(STAD ,BLD ,WLD ,XP ,YP ,ZF ,FAC ,THETA ,IF)	CBL 09390
COMMON /DAT/AERO(150) ,AEROP(50) ,KODE(20) ,LL	CBL 09400
COMMON /PL YCHA/RTD ,XLGTH(5) ,ADC(5,3) ,AFH(5,3) ,TF ,TLFT ,TF	CBL 09410
EQUIVALENCE(AERO(76) ,WLCR) , (AERO(77) ,STACF) , (AEFC(78) ,BLCR)	CBL 09420
PI=3.14159	CBL 09430
XWT=STACF-STAD	CBL 09440
ZWT=WLCR-WLD	CBL 09450
XB=XWT*COS(THE TA)-ZWT*SIN(THE TA)	CBL 09460
ZB=XWT*SIN(THE TA)+ZWT*COS(THE TA)	CBL 09470
T9= BLD -YP	CBL 09480
T10=XB-XP	CBL 09490
XLHIP= SQRT(TS*TS +T10*T10)	CBL 09500
BHIP= ATAN2(TS,T10)	CBL 09510
XLHI= SQRT(XLHIP*XLHIP -RAD*RAD)	CBL 09520
DBHI= ATAN(RAD/XLHI)	CBL 09530
BHI= BHIP -DBHI	CBL 09540
T11=ZB-ZP	CBL 09550
XL=SQRT(XLHI*XLHI+T11*T11)	CBL 09560
TH10=T10-RAD*COS(BHI)	CBL 09570
TH9=T9-RAD*SIN(BHI)	CBL 09580
IF(IF.EQ.3)GO TO 3	CBL 09590
XLGTH(1)=XL	CBL 09600
XLGTH(2)=XL	CBL 09610
ADC(1, 1)=ARCO S(TH10/XL)	CBL 09620
ADC(1, 2)=ARCO S(TH9/XL)	CBL 09630
ADC(1, 3)=ARCO S(T11/XL)	CBL 09640
ADC(2, 1)=-ADC(1, 1)	CBL 09650
ADC(2, 2)=PI-ADC(1, 2)	CBL 09660
ADC(2, 3)=ADC(1, 3)	CBL 09670
ARM(1, 1)=XP-RAD*SIN(BHI)	CBL 09680
ARM(1, 2)=YP+RAD*COS(BHI)	CBL 09690
ARM(1, 3)=0.	CBL 09700
ARM(2, 1)=ARM(1, 1)	CBL 09710
ARM(2, 2)=-ARM(1, 2)	CBL 09720
ARM(2, 3)=0.	CBL 09730
RETURN	CBL 09740
3 XLGTH(3)=XL	CBL 09750
XLGTH(4)=XL	CBL 09760
ADC(3, 1)=ARCO S(TH10/XL)	CBL 09770
ADC(3, 2)=ARCO S(TH9/XL)	CBL 09780
ADC(3, 3)=ARCO S(T11/XL)	CBL 09790
ADC(4, 1)=-ADC(3, 1)	CBL 09800
ADC(4, 2)=PI-ADC(3, 2)	CBL 09810
ADC(4, 3)=ADC(3, 3)	CBL 09820
ARM(3, 1)=XP+RAD*SIN(BHI)	CBL 09830
ARM(3, 2)=YP-RAD*COS(BHI)	CBL 09840
ARM(3, 3)=0.	CBL 09850
ARM(4, 1)=ARM(3, 1)	CBL 09860
ARM(4, 2)=-ARM(3, 2)	CBL 09870
ARM(4, 3)=0.	CBL 09880
RETURN	CBL 09890
END	CBL 09900

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      SUBROUTINE DLGTH(C1,C2,C3,IC,IDX)                                CBL 09910
C   COMPUTES DEL-LGTH EQ FOR X-Z-THETA OR Y-FSI-FHI CCEFF          CBL 09920
      COMMON/PLYCHA/RTD,XLGTH(5),ADC(5,3),ARM(5,3),TF,TLFT,TF      CBL 09930
      IF( IDX.NE.C)GO TO 1                                           CBL 09940
      C1=-COS(ADC(IC,1))                                              CBL 09950
      C2=-COS(ADC(IC,3))                                              CBL 09960
      C3=( ARM( IC,1)*COS(ADC(IC,3))-ARM(IC,3)*CCS(ADC(IC,1)))/12.  CBL 09970
      RETURN                                                         CBL 09980
1   C1=-COS(ADC(IC,2))                                              CBL 09990
      C2=( ARM( IC,2)*COS(ADC(IC,1))-ARM(IC,1)*CCS(ADC(IC,2)))/12.  CBL 10000
      C3=( ARM( IC,3)*COS(ADC(IC,2))-ARM(IC,2)*CCS(ADC(IC,3)))/12.  CBL 10010
      RETURN                                                         CBL 10020
      END                                                            CBL 10030
      SUBROUTINE DCOSLG(IC,CX1,CZ1,CT1,CX3,CZ3,CT3)                 CBL 10040
C   COMPUTES D-DIR COS EQS FOR X-Z-THETA CCEFF.                  CBL 10050
      COMMON/PLYCHA/RTD,XLGTH(5),ADC(5,3),ARM(5,3),TF,TLFT,TF      CBL 10060
      CX1=SIN(ADC(IC,1))/XLGTH(IC)*12.                               CBL 10070
      CZ1=-COS(ADC(IC,3))*COTAN(ADC(IC,1))/XLGTH(IC)*12.           CBL 10080
      XWT=ARM( IC,1)                                                  CBL 10090
      ZWT=ARM( IC,3)                                                  CBL 10100
      CT1=( ZWT*SIN(ADC(IC,1))+XWT*COS(ADC(IC,3))*CCTAN(ADC(IC,1)))/ CBL 10110
      1/XLGTH(IC)                                                    CBL 10120
      CX3=-COS(ADC(IC,1))*COTAN(ADC(IC,3))/XLGTH(IC)*12.           CBL 10130
      CZ3=SIN(ADC(IC,3))/XLGTH(IC)*12.                              CBL 10140
      CT3=- ( ZWT*COS(ADC(IC,1))*COTAN(ADC(IC,3))+XWT*SIN(ADC(IC,3)) ) CBL 10150
      1/XLGTH(IC)                                                    CBL 10160
      RETURN                                                         CBL 10170
      END                                                            CBL 10180
C   THIS IS A SINGLE PRECISION VERSION OF CABLE4 TC EE USED      CBL 10190
C   WITH THE LRC MATRIX REDUCTION AND IBM RCCT                   CBL 10200
C   FINDING ROUTINE                                               CBL 10210
      SUBROUTINE LONG                                              CBL 10220
      COMMON /DAT/ AERO(150),AEROP(50),KODE(20),LL                 CBL 10230
      COMMON / PLYCHA/RTD,XLGTH(5),ADC(5,3),AFH(5,3),TF,TLFT,TF    CBL 10240
      COMMON /DU/DUM(10,10)                                         CBL 10250
      EQUIVALENCE(AERO(46), XCG),(AERO(47), ZCG)                   CBL 10260
      EQUIVALENCE(AERO(63),THETA),(AERO(49),VC),(AERO(50), AM)      CBL 10270
      EQUIVALENCE(AERO(51),RHO),(AERO(52), WT),(AERO(53),B)         CBL 10280
      EQUIVALENCE(AERO(54),CBAR),(AERO(55),SH),(AERO(56), XIXZ)     CBL 10290
      EQUIVALENCE(AERO(57),XIXX),(AERO(58),YIYY),(AERO(56),ZIZZ),   CBL 10300
1     (AERO(55),AKR),(AERO(100),AKLFT)                             CBL 10310
      EQUIVALENCE(AERO(123),AKSY),(AERO(124),AKFHI),(AERO(125),AKTHE), CBL 10320
1     (AERO(126),AKAZ),(AERO(127),T1SY),(AERO(128),T2PHI),        CBL 10330
2     (AERO(129),T3THE),(AERO(130),T4A2)                          CBL 10340
      EQUIVALENCE(AEROP( 1),CXUP),(AEROP( 2),C2UF),(AEROP( 3),CMUP), CBL 10350
1     (AEROP( 4),CXAP),(AEROP( 5),C2AF),(AEROP( 6),CMAP),          CBL 10360
2     (AEROP( 7),CXQP),(AEROP( 8),C2CF),(AEROP( 9),CMQP),          CBL 10370
3     (AEROP(10),CXOP),(AEROP(11),C2CF),(AEROP(12),CMOP),          CBL 10380
4     (AEROP(13),CXDEP),(AEROP(14),C2CEF),(AEROP(15),CMDEP),       CBL 10390
5     (AEROP(16),CXADP),(AEROP(17),C2ADF),(AEROP(18),CMADP),       CBL 10400
6     (AEROP(19),CYBP),(AEROP(20),CLEF),(AEROP(21),CNBP),          CBL 10410
7     (AEROP(22),CYPP),(AEROP(23),CLFF),(AEROP(24),CNPP),          CBL 10420
8     (AEROP(25),CYRP),(AEROP(26),CLRF),(AEROP(27),CNRP),          CBL 10430
9     (AEROP(28),CYDRP),(AEROP(29),CLCRP),(AEROP(30),CNDRP),        CBL 10440
A     (AEROP(31),CYDAP),(AEROP(32),CLDAF),(AEROP(33),CNDAP),       CBL 10450
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B	(AEROP(34),CYDSP),(AEROP(35),CLCSF),(AERCF(36),CNDSP)	CBL 10460
	DIMENSION CMAT(7,7,3)	CBL 10470
	COMPLEX ROOTS(25)	CBL 10480
	COMMON/SNUBB/SNU(3,3),SN(30),THUSN,THLSN,SNUC(3,3)	CBL 10490
	COMMON/ROUGH/FRIC(3,6)	CBL 10500
	DIMENSION FXS(3,4)	CBL 10510
	DO 10 J=1,3	CBL 10520
	DO 10 K=1,4	CBL 10530
10	FXS(J,K)=0.	CBL 10540
	DO 1 IC=1,5	CBL 10550
	DO 3 J=1,10	CBL 10560
	DO 3 K=1,10	CBL 10570
3	DUM(J,K)=0.	CBL 10580
	TENS=TF	CBL 10590
	IF(IC.GT.2) TENS=TR	CBL 10600
	IF(IC.GT.4) TENS=TLFT	CBL 10610
	DUM(1,2)= - TENS * COS(ADC(IC,3))	CBL 10620
	DUM(1,5)= - TENS * SIN(ADC(IC,1))	CBL 10630
	DUM(2,2)= TENS * COS(ADC(IC,1))	CBL 10640
	DUM(2,6)= - TENS * SIN(ADC(IC,3))	CBL 10650
	DUM(3,2)=(ARM(IC,3)*DUM(1,2)-ARM(IC,1)*DUM(2,2))/12.	CBL 10660
	DUM(3,5)= ARM(IC,3)*DUM(1,5)/12.	CBL 10670
	DUM(3,6)=-ARM(IC,1)*DUM(2,6)/12.	CBL 10680
	IF(IC.GT.2) GO TO 2	CBL 10690
	DUM(1,3)=COS(ADC(IC,1))	CBL 10700
	DUM(2,3)=COS(ADC(IC,3))	CBL 10710
	DUM(3,3)=(ARM(IC,3)*DUM(1,3)-ARM(IC,1)*DUM(2,3))/12.	CBL 10720
	CALL DLGTH(CX,CZ,CT,1,0)	CBL 10730
✓	CALL DLGTH(CXP,CZP,CTP,2,0)	CBL 10740
	CX= CX + CXP	CBL 10750
	XPZ =-(CZ+CZP)/CX	CBL 10760
	DUM(4,1)=XPZ	CBL 10770
	XPT =-(CT+CTP)/CX	CBL 10780
	DUM(4,2)=XPT	CBL 10790
	DUM(4,4)= -1	CBL 10800
	CALL DCOSLG(IC,DUM(5,4),DUM(5,1),DUM(5,2),DUM(6,4),	CBL 10810
1	DUM(6,1),DUM(6,2))	CBL 10820
	DUM(5,5)=-1	CBL 10830
	DUM(6,6)=-1	CBL 10840
	CALL MASH(3,6)	CBL 10850
	DO 4 J=1,3	CBL 10860
	DO 4 K=1,3	CBL 10870
4	FXS(J,K)=FXS(J,K)+DUM(J,K)	CBL 10880
	GO TO 1	CBL 10890
2	IF(IC.GT.4)GO TO 5	CBL 10900
	DUM(1,4)=COS(ADC(IC,1))	CBL 10910
	DUM(2,4)=COS(ADC(IC,3))	CBL 10920
	DUM(3,4)=(ARM(IC,3)*DUM(1,4)-ARM(IC,1)*DUM(2,4))/12.	CBL 10930
	CALL DLGTH(CX,CZ,CT,3,0)	CBL 10940
	CALL DLGTH(CXP,CZP,CTP,4,0)	CBL 10950
	DUM(7,1)=CZ+CZP	CBL 10960
	DUM(7,2)=CT+CTP	CBL 10970
	DUM(7,3)=CX+CXP	CBL 10980
	DUM(4,7)=AKR*12.	CBL 10990
5	CALL DCOSLG(IC,DUM(5,3),DUM(5,1),DUM(5,2),DUM(6,3),DUM(6,1),DUM	CBL 11000

1(6,2))	CBL 11010
DUM(4,4)=-1	CBL 11020
DUM(5,5)=-1	CBL 11030
DJM(6,6)=-1	CBL 11040
DUM(7,7)=-1	CBL 11050
CALL MASH(3,7)	CBL 11060
DO 6 J=1,3	CBL 11070
DO 6 K=1,3	CBL 11080
IF(K.NE.3)FXS(J,K)=FXS(J,K)+DLM(J,K)	CBL 11090
6 IF(K.EQ.3)FXS(J,4)=FXS(J,4)+DLM(J,K)	CBL 11100
GO TO 1	CBL 11110
5 IF(KODE(11).EQ.C)GO TO 1	CBL 11120
CALL DLGTH(DUM(7,3),DUM(7,1),DUM(7,2),5,0)	CBL 11130
DUM(4,7)=AKLFT*12.	CBL 11140
GO TO 8	CBL 11150
1 CONTINUE	CBL 11160
ADD SNUBBER INCREMENTS	CBL 11170
CALL LONGSN	CBL 11180
DO 7 J=1,3	CBL 11190
FXS(J,1)=FXS(J,1)+SNU(J,2)	CBL 11200
FXS(J,2)=FXS(J,2)+SNU(J,3)	CBL 11210
7 FXS(J,4)=FXS(J,4)+SNU(J,1)	CBL 11220
CALL FRICT(0)	CBL 11230
THE CABLE FORCES/MOMENTS PARTIALS ARE COMPLETED	CBL 11240
AERO. DATA IS NOW COMPUTED	CBL 11250
Q=RHO*VO*VO/2.	CBL 11260
QS=Q*SW	CBL 11270
QSV=QS/VO	CBL 11280
XU=CXUP*QSV	CBL 11290
ZU=CZUP*QSV	CBL 11300
EMU=CMUP*QSV*CBAR	CBL 11310
XA=CXAP*QSV	CBL 11320
ZA=CZAP*QSV	CBL 11330
EMA=CMAP*QSV*CBAR	CBL 11340
XQ=CXQP*QSV*CBAR/(VO*2.)	CBL 11350
ZQ=CZQP*QSV*CBAR/(VO*2.)	CBL 11360
EMQ=CMQP*QSV*CBAR/2.	CBL 11370
XDE=CXDEP*QS	CBL 11380
ZDE=CZDEP*QS	CBL 11390
EMDE=CMDEP*QS*CBAR	CBL 11400
XAD=CXADP*QSV*CBAR/(VO*2.)	CBL 11410
ZAD=CZADP*QSV*CBAR/(VO*2.)	CBL 11420
EMAD=CMADP*QSV*CBAR/(2.*VO)	CBL 11430
IROW=7	CBL 11440
ICOL=7	CBL 11450
IORDER=3	CBL 11460
DO 20 I=1, IROW	CBL 11470
DO 20 J=1, ICOL	CBL 11480
DO 20 K=1, IORDER	CBL 11490
20 CMAT(I,J,K)=0.	CBL 11500
FX EQUATION	CBL 11510
CMAT(1,1,1)=-FXS(1,1)	CBL 11520
CMAT(1,1,2)=-XA-SNUD(1,2)-FRIC(1,5)-FRIC(1,2)	CBL 11530
CMAT(1,1,3)=-XAD	CBL 11540
CMAT(1,2,1)=-FXS(1,2)+WT*COS(THETA)-XA*VC	CBL 11550

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      CMAT(1,2,2)=-XQ-XAD*VO-SNUD(1,3)-FRIC(1,6)-FRIC(1,3)      CBL 11560
      CMAT(1,2,3)=ZCG*AM/12.      CBL 11570
      CMAT(1,3,1)=-FXS(1,3)      CBL 11580
      CMAT(1,4,1)=-FXS(1,4)      CBL 11590
      CMAT(1,4,2)=-XL-SNUD(1,1)-FRIC(1,4)-FRIC(1,1)      CBL 11600
      CMAT(1,4,3)=AM      CBL 11610
      CMAT(1,5,1)=-XDE      CBL 11620
C  FZ EQUATION      CBL 11630
      CMAT(2,1,1)=-FXS(2,1)      CBL 11640
      CMAT(2,1,2)=-ZA-SNUD(2,2)-FRIC(2,5)-FRIC(2,2)      CBL 11650
      CMAT(2,1,3)=AM-ZAD      CBL 11660
      CMAT(2,2,1)=-FXS(2,2)+WT*SIN(THETA)-ZA*VC      CBL 11670
      CMAT(2,2,2)=-ZQ-ZAD*VO-SNUD(2,3)-FRIC(2,6)-FRIC(2,3)      CBL 11680
      CMAT(2,2,3)=-XCG*AM/12.      CBL 11690
      CMAT(2,3,1)=-FXS(2,3)      CBL 11700
      CMAT(2,4,1)=-FXS(2,4)      CBL 11710
      CMAT(2,4,2)=-ZL-SNUD(2,1)-FRIC(2,4)-FRIC(2,1)      CBL 11720
      CMAT(2,5,1)=-ZDE      CBL 11730
C  MOMENT EQUATION      CBL 11740
      CMAT(3,1,1)=-FXS(3,1)      CBL 11750
      CMAT(3,1,2)=-EMA-SNUD(3,2)-FRIC(3,5)-FRIC(3,2)      CBL 11760
      CMAT(3,1,3)=-EMAD*CBAR+XCG*AM/12.      CBL 11770
      CMAT(3,2,1)=-FXS(3,2)-EMA*VO+ZCG*WT*CCS(THETA)/12.      CBL 11780
      1-XCG*WT*SIN(THETA)/12.      CBL 11790
      CMAT(3,2,2)=-EMQ-EMAD*VO)*CBAR-SNUD(3,3)-FRIC(3,6)-FRIC(3,3)      CBL 11800
      CMAT(3,2,3)=YIYY      CBL 11810
      CMAT(3,3,1)=-FXS(3,3)      CBL 11820
      CMAT(3,4,1)=-FXS(3,4)      CBL 11830
      CMAT(3,4,2)=-FML-SNUD(3,1)-FRIC(3,4)-FRIC(3,1)      CBL 11840
      CMAT(3,4,3)=ZCG*AM/12.      CBL 11850
      CMAT(3,5,1)=-EMDE      CBL 11860
C  CONSTRAINT EQUATION      CBL 11870
      CMAT(4,1,1)=-XPZ      CBL 11880
      CMAT(4,2,1)=-XPT      CBL 11890
      CMAT(4,4,1)=1      CBL 11900
C  FEEDBACK LOOP EQUATION      CBL 11910
      CMAT(5,2,2)=AKTHE      CBL 11920
      CMAT(5,5,2)=-T4THE      CBL 11930
      CMAT(5,5,1)=-1.      CBL 11940
      IW=6      CBL 11950
      N=KODE(8)      CBL 11960
      CALL MATRIX(CMAT,N,ROOTS,K4A,IER)      CBL 11970
      IF(KODE(5).NE.0) WRITE(IW,100) IER      CBL 11980
100  FORMAT(2X,'IER=',I3,3X,'SEE SUBR. PCFB AND FREM FOR ERROR CODE')      CBL 11990
C  THE ROOTS OF THE CHARAC. EQUAT. ARE IN THE COMPLEX ARRAY 'ROOTS'      CBL 12000
C  AND THE NUMBER OF ROOTS IS 'K4A'      CBL 12010
      CALL PRINTR(IW,ROOTS,K4A)      CBL 12020
      RETURN      CBL 12030
      END      CBL 12040
      SUBROUTINE PRINTR (LOUT,RT,NRCCT)      CBL 12050
      DIMENSION RT(2,1)      CBL 12060
COMMENT  PRINTS PERTINENT INFORMATION ABOUT CHARACTERISTIC ROOTS      CBL 12070
      WRITE(LOUT,507)      CBL 12080
50  FORMAT(      *      REAL      IMAGINARY      T H/C-SEC      1/T H/*,      CBL 12090
      1      *D      PERIOD-SEC      DNATF-CFS      UNDNAT-CPS      DAMP *,      CBL 12100

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2          'RATIO      DECAY RATIO '
NEXT=1
DO 530 I=1,NROOT
  IF(NEXT.EQ.2) GO TO 777
  SIG=RT(1,1)
  ASIG=ABS(SIG)
  AWD=ABS(RT(2,1))
  THDI= ASIG*1.442695
  THD= 99999.
  IF(THDI.GT.1.E-5) THD= 1./THDI
  IF(AWD.EQ.0.) GO TO 531
  NEXT=2
  WD=-AWD
  DNAT= AWD * .159155
  PER= 99999.
  IF(DNAT.GT.1.E-5) PER= 1./DNAT
  UNDNAT= SQRT(ASIG**2+AWD**2) *.1591550
  DAMPR= 0.
  IF( AWD - 1.E15 * ASIG ) 503,504,504
503 DAMPR= SIGN ( COS( ATAN ( AWD/ASIG ) ), -SIG )
504 CHDI= THDI*PER
  DECR= 99999.
  ARG= SIG * PER
  IF(ARG.LT.174.6) DECR= EXP (ARG)
  WRITE(LOUT,529) SIG,WD,THD,THDI,PER,DNAT,UNDNAT,DAMPR,CHDI,DECR
529 FORMAT(1PE12.4,2X,1H+,1PE11.4,1P8E13.4)
  GO TO 530
5  WRITE(LOUT,532) SIG,THD,THDI
532 FORMAT(1PE12.4,14X,2E13.4)
  GO TO 530
777 NEXT=1
530 CONTINUE
  RETURN
  END
  SUBROUTINE MASH (NN,N)
  COMMON /DU/DUM(10,10)
  C NN = FINAL MATRIX SIZE
  C N = ORIGINAL MATRIX SIZE
  INN=N-NN
  DO 1001 LL=1,INN
  L=N+1-LL
  II=L-1
  JJ=L-1
  DO 1001 I=1,II
  DO 1001 J=1,JJ
1001 DUM(I,J)= DUM(I,J)+DUM(L,J)*DUM(I,L)/(-DUM(L,L))
  RETURN
  END
  SUBROUTINE LAT
  COMMON /DAT/ AERO(150),AEROP(50),KODE(20),LL
  COMMON / PLYCHA/RTD,XLGTH(5),ADC(5,3),AFN(5,3),TF,TLFT,TF
  COMMON /DU/DUM(10,10)
  EQUIVALENCE(AERO(46), XCG),{AERO(47), 2CG)
  EQUIVALENCE(AERO(63),THE TA),{AERO(49),V( )},{AERO(50), AM)
  EQUIVALENCE(AERO(51),RHO ),{AERO(52), WT},{AERO(53),B )

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)CBL 12110
 CBL 12120
 CBL 12130
 CBL 12140
 CBL 12150
 CBL 12160
 CBL 12170
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 CBL 12570
 CBL 12580
 CBL 12590
 CBL 12600
 CBL 12610
 CBL 12620
 CBL 12630
 CBL 12640
 CBL 12650

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EQUIVALENCE(AERO (54),CBAR ),(AERO (55),SV ),(AERC (56), XIXZ) CBL 12660
EQUIVALENCE(AERO (57),XIXX ),(AERO (58),YIYY ),(AERC (59),ZIZZ ), CBL 12670
1 (AERO(95),AKR),(AERO(100),AKLFT) CBL 12680
EQUIVALENCE(AERO(123), AKSY),(AERO(124),A1FHI),(AERC(125),AKTHE), CBL 12690
1 (AERO(126),AKAZ),(AERO(127),T1SY),(AERC(128),T2PHI), CBL 12700
2 (AERO(129),T3THE),(AERO(130),T4AZ) CBL 12710
EQUIVALENCE(AEROP( 1),CXUP),(AEROP( 2),C2LF),(AEROP( 3),CMUP), CBL 12720
1 (AEROP( 4),CXAP),(AEROP( 5),C2AP),(AEROP( 6),CMAP), CBL 12730
2 (AEROP( 7),CXQP),(AEROP( 8),C2CF),(AEROP( 9),CMQP), CBL 12740
3 (AEROP(10),CXOP),(AEROP(11),C2CF),(AEROP(12),CMOP), CBL 12750
4 (AEROP(13),CXDP),(AEROP(14),C2CF),(AEROP(15),CMDEP), CBL 12760
5 (AEROP(16),CXADP),(AEROP(17),C2CF),(AEROP(18),CMADP), CBL 12770
6 (AEROP(19),CYBP),(AEROP(20),CLBF),(AEROP(21),CNBP), CBL 12780
7 (AEROP(22),CYPP),(AEROP(23),CLFF),(AEROP(24),CNPP), CBL 12790
8 (AEROP(25),CYRP),(AEROP(26),CLFF),(AEROP(27),CNRP), CBL 12800
9 (AEROP(28),CYDRP),(AEROP(29),CLCFF),(AEROP(30),CNDRP), CBL 12810
A (AEROP(31),CYDAP),(AEROP(32),CLCAF),(AEROP(33),CNDAP), CBL 12820
B (AEROP(34),CYDSP),(AEROP(35),CLCSF),(AEROP(36),CNDSP) CBL 12830
DIMENSION CMAT(7,7,3) CBL 12840
COMPLEX ROOTS(29) CBL 12850
COMMON/SNUBB/SNU(3,3),SN(30),THUSN,THLSN,SNLC(3,3) CBL 12860
COMMON /ROUGH/FRIC(3,6) CBL 12870
DIMENSION FXS(3,3) CBL 12880
DO 10 J=1,3 CBL 12890
DO 10 K=1,3 CBL 12900
10 FXS(J,K)=0. CBL 12910
DO 111 IC=1,5 CBL 12920
IF(KODE(11).EQ.0.AND.IC.EQ.5)GO TO 1 CBL 12930
DO 3 J=1,8 CBL 12940
DO 3 K=1,8 CBL 12950
3 DUM(J,K)=0. CBL 12960
TENS=TF CBL 12970
IF( IC.GT.2)TENS=TR CBL 12980
IF( IC.GT.4)TENS=TLFT CBL 12990
CA1=COS(ADC(IC,1)) CBL 13000
CA2=COS(ADC(IC,2)) CBL 13010
CA3=COS(ADC(IC,3)) CBL 13020
IF(ABS(CA1).LT..0001) CA1=0. CBL 13030
IF(ABS(CA2).LT..0001) CA2=0. CBL 13040
IF(ABS(CA3).LT..0001) CA3=0. CBL 13050
DUM( 1,2)=-TENS*CA1 CBL 13060
DUM( 1,3)=TENS*CA3 CBL 13070
DUM( 1,4)=CA2 CBL 13080
DUM( 1,6)=-TENS*SIN(ADC(IC,2)) CBL 13090
DUM(2,2)=( ARM(IC,1)*DUM(1,2)-ARM(IC,2)*TENS*CA2)/12. CBL 13100
DUM(2,3)= ARM(IC,1)*DUM(1,3)/12. CBL 13110
DUM(2,4)=(ARM(IC,1)*CA2-ARM(IC,2)*CA1)/12. CBL 13120
DUM(2,5)= ARM(IC,2)*TENS*SIN(ADC(IC,1))/12. CBL 13130
DUM(2,6)= ARM(IC,1)*DUM(1,6)/12. CBL 13140
DUM(4,4)=-1. CBL 13150
DUM(4,8)=0. CBL 13160
IF( IC.GT.2)DUM(4,8)=AKR*12. CBL 13170
IF( IC.GT.4)DUM(4,8)=AKLFT*12. CBL 13180
DUM(3,2)=-ARM(IC,3)*DUM(1,2)/12. CBL 13190
DUM(3,3)=(-ARM(IC,3)*DUM(1,3)-ARM(IC,2)*TENS*CA2)/12. CBL 13200

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DUM(3,4)=(ARM(IC,2)*CA3-ARM(IC,3)*CA2)/12.	CBL 13210
DUM(3,7)=-ARM(IC,2)*TENS*SIN(ADC(IC,1))/12.	CBL 13220
DUM(3,6)=-ARM(IC,3)*DUM(1,6)/12.	CBL 13230
CALL DCOSD(IC,DUM(5,1),DUM(5,2),DUM(5,3),CLN(6,1),DUM(6,2),DUM(CBL 13240
16,3),DUM(7,1),DUM(7,2),DUM(7,3))	CBL 13250
DUM(5,5)=-1.	CBL 13260
DJM(6,6)=-1.	CBL 13270
DUM(7,7)=-1.	CBL 13280
IF(IC.GT.2)GO TO 2	CBL 13290
CALL MASH(3,7)	CBL 13300
6 DO 4 J=1,3	CBL 13310
DO 4 K=1,3	CBL 13320
4 FXS(J,K)=FXS(J,K)+DUM(J,K)	CBL 13330
GO TO 1	CBL 13340
2 IF(IC.GT.4)GO TO 5	CBL 13350
CALL DLGTH(CY,CPS,CPH,3,1)	CBL 13360
CALL DLGTH(CYP,CPSP,CPP,4,1)	CBL 13370
DUM(8,1)=CY+CYP	CBL 13380
DUM(8,2)=CPS+CPSP	CBL 13390
DUM(8,3)=CPH+CPP	CBL 13400
DUM(8,8)=-1.	CBL 13410
CALL MASH(3,8)	CBL 13420
GO TO 6	CBL 13430
5 IF(KODE(11).EQ.0)GO TO 1	CBL 13440
CALL DLGTH(DUM(8,1),DUM(8,2),DUM(8,3),5,1)	CBL 13450
DUM(8,8)=-1.	CBL 13460
GO TO 6	CBL 13470
CONTINUE	CBL 13480
1) CONTINUE	CBL 13490
2 COMPLETE SUMMATION OF CABLE FORCES & MOMENTS	CBL 13500
3 ADD SNUBBER INCREMENTS	CBL 13510
112 CALL LATSN	CBL 13520
DO 9 J=1,3	CBL 13530
DO 9 K=1,3	CBL 13540
8 FXS(J,K)=FXS(J,K)+SNU(J,K)	CBL 13550
CALL FRIC(1)	CBL 13560
4 ADD AERO INCREMENTS	CBL 13570
Q=.5*RHO*VO*VO	CBL 13580
QS=Q*SW	CBL 13590
QSV=QS/VO	CBL 13600
BOV=B/(2.*VO)	CBL 13610
YV=CYBP*QSV	CBL 13620
ELV=CLBP*QSV*B	CBL 13630
ENV=CNBP*QSV*B	CBL 13640
YP=CYP*QSV*BOV	CBL 13650
ELP=CLP*QSV*BOV	CBL 13660
ENP=CNP*QSV*BOV	CBL 13670
YR=CYRP*QSV*BOV	CBL 13680
ELR=CLRP*QSV*BOV	CBL 13690
ENR=CNRP*QSV*BOV	CBL 13700
YDR=CYDRP*QS	CBL 13710
ENDR=CNDRP*QS*B	CBL 13720
ELDR=CLDRP*QS*B	CBL 13730
YDA=CYDAP*QS	CBL 13740
ENDA=ENDAP*QS*B	CBL 13750

EL DA=CLDAP*QS*B	CBL 13760
YDS=CYDSP*QS	CBL 13770
ENCS=CNDSP*QS*B	CBL 13780
EL DS=CLDSP*QS*B	CBL 13790
DO 113 I=1,7	CBL 13800
DO 113 J=1,7	CBL 13810
DO 113 K=1,3	CBL 13820
113 CMAT(I,J,K)=0.	CBL 13830
C Y FORCE EQUATION	CBL 13840
CMAT(1,1,1)=-FXS(1,1)	CBL 13850
CMAT(1,1,2)=-YV-SNUD(1,1)-FRIC(1,4)-FRIC(1,1)	CBL 13860
CMAT(1,1,3)=AM	CBL 13870
CMAT(1,2,1)=-FXS(1,2)+YV*VD-WT*SIN(THETA)	CBL 13880
CMAT(1,2,2)=-YR-SNUD(1,2)-FRIC(1,5)-FRIC(1,2)	CBL 13890
CMAT(1,2,3)=AM*XCG/12.	CBL 13900
CMAT(1,3,1)=-FXS(1,3)-WT*COS(THETA)	CBL 13910
CMAT(1,3,2)=-YP-SNUD(1,3)-FRIC(1,6)-FRIC(1,3)	CBL 13920
CMAT(1,3,3)=-AM*ZCG/12.	CBL 13930
CMAT(1,4,1)=-QS*CYDRP	CBL 13940
CMAT(1,5,1)=-QS*CYDAP	CBL 13950
C YAW EQUATION	CBL 13960
CMAT(2,1,1)=-FXS(2,1)	CBL 13970
CMAT(2,1,2)=-ENV-SNUD(2,1)-FRIC(2,4)-FRIC(2,1)	CBL 13980
CMAT(2,1,3)=AM*XCG/12.	CBL 13990
CMAT(2,2,1)=-FXS(2,2)+ENV*VD-XCG*WT*SIN(THETA)/12.	CBL 14000
CMAT(2,2,2)=-ENR-SNUD(2,2)-FRIC(2,5)-FRIC(2,2)	CBL 14010
CMAT(2,2,3)=ZIZZ	CBL 14020
CMAT(2,3,1)=-FXS(2,3)+XCG*WT*CCS(THETA)/12.	CBL 14030
CMAT(2,3,2)=-ENP-SNUD(2,3)-FRIC(2,6)-FRIC(2,3)	CBL 14040
CMAT(2,3,3)=-XIXZ	CBL 14050
CMAT(2,4,1)=-QS*B*CNDRP	CBL 14060
CMAT(2,5,1)=-QS*R*CNDAP	CBL 14070
C ROLL EQUATION	CBL 14080
CMAT(3,1,1)=-FXS(3,1)	CBL 14090
CMAT(3,1,2)=-ELV-SNUD(3,1)-FRIC(3,4)-FRIC(3,1)	CBL 14100
CMAT(3,1,3)=-AM*ZCG/12.	CBL 14110
CMAT(3,2,1)=-FXS(3,2)+ELV*VD-ZCG*WT*SIN(THETA)/12.	CBL 14120
CMAT(3,2,2)=-ELR-SNUD(3,2)-FRIC(3,5)-FRIC(3,2)	CBL 14130
CMAT(3,2,3)=-XIXZ	CBL 14140
CMAT(3,3,1)=-FXS(3,3)-ZCG*WT*CCS(THETA)/12.	CBL 14150
CMAT(3,3,2)=-ELP-SNUD(3,3)-FRIC(3,6)-FRIC(3,3)	CBL 14160
CMAT(3,3,3)=XIXX	CBL 14170
CMAT(3,4,1)=-QS*B*CLDRP	CBL 14180
CMAT(3,5,1)=-QS*B*CLDAP	CBL 14190
C RUDDER FEEDBACK LOOP	CBL 14200
CMAT(4,2,2)=AKSY	CBL 14210
CMAT(4,4,2)=-T2SY	CBL 14220
CMAT(4,4,1)=-1.	CBL 14230
CAILERON FEEDBACK LOOP	CBL 14240
CMAT(5,3,2)=AKPHI	CBL 14250
CMAT(5,5,2)=-T2PHI	CBL 14260
CMAT(5,5,1)=-1.	CBL 14270
IW=6	CBL 14280
N=KODE(9)	CBL 14290
CALL MATRIX(CMAT,N,ROOTS,K4A,IER)	CBL 14300

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      IF(KODE(5).NE.C) WRITE(IW,100) IER
100 FORMAT(2X,'IER=',I3,3X,'SEE SLBR. PQFB AND FEEN FOR ERROR CODE')
C   HE ROOTS OF THE CHARACTERISTIC EQ. ARE IN THE COMPLEX ARRAY
C   'ROOTS' AND THE NUMBER OF ROOTS IS 'K4A'
      CALL PRINTR(IW,ROOTS,K4A)
      RETURN
      END
      SUBROUTINE DCOSD(IC,CY1,CPSI1,CPHI1,CY2,CPSI2,CPHI2,CY3,CPSI3,
1CPHI3)
      COMMON /PLYCHA/RTD,XLGTH(5),ADC(5,3),AFN(5,3),TR,TLFT,TF
      XWT=ARM(IC,1)
      YWT=ARM(IC,2)
      ZWT=ARM(IC,3)
      CY1=-COS(ADC(IC,2))*COTAN(ADC(IC,1))/XLGTH(IC)*12.
      CPSI1=-(YWT*SIN(ADC(IC,1))+XWT*COS(ADC(IC,2))*CCTAN(ADC(IC,1))
1/XLGTH(IC)
      CPHI1=(ZWT*COS(ADC(IC,2))*COTAN(ADC(IC,1))-YWT*CCS(ADC(IC,3))*
1COTAN(ADC(IC,1)))/XLGTH(IC)
      CY2=SIN(ADC(IC,2))/XLGTH(IC)*12.
      CPSI2=(YWT*COS(ADC(IC,1))*COTAN(ADC(IC,2))+XWT*SIN(ADC(IC,2)))/
1XLGTH(IC)
      CPHI2=-(ZWT*SIN(ADC(IC,2))+YWT*COS(ADC(IC,3))*CCTAN(ADC(IC,2))
1/XLGTH(IC)
      CY3=-COS(ADC(IC,2))*COTAN(ADC(IC,3))/XLGTH(IC)*12.
      CPSI3=(YWT*COS(ADC(IC,1))*COTAN(ADC(IC,3))-XWT*CCS(ADC(IC,2))*
1COTAN(ADC(IC,3)))/XLGTH(IC)
      CPHI3=(ZWT*COS(ADC(IC,2))*COTAN(ADC(IC,3))+YWT*SIN(ADC(IC,3))
1/XLGTH(IC)
      RETURN
      END
      SUBROUTINE SNTRM (FXSN,FZSN,AMSN,THETA)
      COMMON /DAT/AERO(150),AEROP(50),KODE(20),LL
      COMMON /ZZZ(200)
      COMMON /TAB1/ZZ(ECC)
      COMMON /SNUB/SNU(3,3),SN(30),THUSN,THLSN,SNUC(3,3)
      EQUIVALENCE (AERO(105),SNLX),(AERO(106),SNLY),(AERO(107),SNUZ),
1(AERO(108),SNLX),(AERO(109),SNLY),(AERO(110),SNLZ),
2(AERO(111),SNLST),(AERO(112),SNLWL),(AERO(113),SNUBL),
3(AERO(114),SNLST),(AERO(115),SNLWL),(AERO(116),SNLBL),
4(AERO(117),TUSNO),(AERO(118),TUSNC),(AERO(119),AKSNU),
5(AERO(120),AKSNL),(AERO(49),VC),(AERO(51),RHO),
6(AERO(76),WLCR),(AERO(77),STACF),
7(AERO(78),BLCR)
      EQUIVALENCE (SN(1),GX1),(SN(2),GY1),(SN(3),GZ1),
1(SN(4),GX2),(SN(5),GY2),(SN(6),GZ2),
2(SN(7),GX3),(SN(8),GY3),(SN(9),GZ3),
3(SN(10),GX4),(SN(11),GY4),(SN(12),GZ4),
4(SN(13),THU),(SN(14),THL),(SN(15),ALU),
5(SN(16),ALL),
6(SN(19),THGX1),(SN(20),THGY1),(SN(21),THGZ1),
7(SN(22),THGX2),(SN(23),THGY2),(SN(24),THGZ2),
8(SN(25),THGX3),(SN(26),THGY3),(SN(27),THGZ3),
9(SN(28),THGX4),(SN(29),THGY4),(SN(30),THGZ4)
      IW=6
      IF(KODE(10).EQ.C) GO TO 5005

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      CALL DRC SN(THETA)
      IF(KODE(10).NE.1) GO TO 5003
C   RMS TO MODEL SNUBBER EFFECTS (MODEL UNSNUBBERED)
      Q=.5*RH0*V0*V0
      CALL STINT(Q,ALU,0,1,1,TUSN,NG)
      IF(NG.NE.0) GO TO 5000
      CALL STINT(Q,ALL,0,1,1,TL SN,NG)
      IF(NG.NE.0) GO TO 5000
      CALL STINT(Q,ALU,0,2,2,THUSN,NG)
      IF(NG.NE.0) GO TO 5000
      CALL STINT(Q,ALL,0,2,2,THLSN,NG)
      IF(NG.EQ.0) GO TO 5001
5000 WRITE(IW,5002) NG,ALL,ALU,Q
5002 FORMAT(2X,'ERROR IN SNUBBER TABLE 1-2  , NG=',I3,3E10.3)
      RETURN
5001 CONTINUE
C   CALCULATING FORCE AND MOMENT EFFECTS
      CALL DRCUSN(THETA)
      FXUSN= 2.*TUSN*GX1
      FZUSN= 2.*TUSN*GZ1
      AMUSN= -FXLSN*SNLZ+SNLX*FZLSN
      FXLSN= 2.*TL SN*GX3
      FZLSN= 2.*TL SN*GZ3
      AMLS N= FXLSN*SNLZ+FZLSN*SNLX
      FX SN = FXUSN+FXLSN
      FZ SN = FZUSN+FZLSN
      AMSN =(AMUSN+AMLSN)/12.
      RETURN
5003 CONTINUE
C   TERMS TO MODEL SNUBBER EFFECTS (MODEL SNUBBERED)
      FXUSN= 2.*TUSNO*GX1
      FZUSN= 2.*TUSNO*GZ1
      AMUSN =-FXUSN*SNLZ+FZUSN*SNLX
      FXLSN= 2.*TL SNO*GX3
      FZLSN= 2.*TL SNO*GZ3
      AMLS N = FXLSN*SNLZ+FZLSN*SNLX
      FX SN = FXUSN+FXLSN
      FZ SN = FZUSN+FZLSN
      AMSN =(AMUSN+AMLSN)/12.
      RETURN
5005 FX SN=0
      FZ SN=0
      AMSN=0
      RETURN
      END
      SUBROUTINE LONGSN
      COMMON/DAT/AERO(150),AEROP(50),KODE(20),LL
      COMMON/SNUBB/SNU(3,3),SN(30),THUSN,THLSN,SNUC(3,3)
      COMMON ZZZ(200)
      COMMON/TAB1/ZZ(800)
      COMMON/DL/CLM(10,10)
      EQUIVALENCE(AERO(105), SNLX),(AERO(106), SNLY),(AERO(107), SNLZ),
1          (AERO(108), SNLX),(AERO(109), SNLY),(AERO(110), SNLZ),
2          (AERO(111), SNLST),(AERO(112), SNLWL),(AERO(113), SNLWL),
3          (AERO(114), SNLST),(AERO(115), SNLWL),(AERO(116), SNLWL),

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4      (AERO(117),TUSNO),(AERO(118),TUSNC),(AERO(119),AKSNU),CBL 15410
5      (AERO(120),AKSNL),(AERO(49), VC),(AERO(51), RHO),CBL 15420
6      (AERO(63),THE TA),(AERO(121),ACSAU),(AERO(122),ACSNL)CBL 15430
EQUIVALENCE (SN( 1), GX1),(SN( 2), GY1),(SN( 3), GZ1),CBL 15440
1      (SN( 4), GX2),(SN( 5), GY2),(SN( 6), GZ2),CBL 15450
2      (SN( 7), GX3),(SN( 8), GY3),(SN( 9), GZ3),CBL 15460
3      (SN(10), GX4),(SN(11), GY4),(SN(12), GZ4),CBL 15470
4      (SN(13), THU),(SN(14), THL),(SN(15), ALU),CBL 15480
5      (SN(16), ALL),CBL 15490
6      (SN(19),THGX1),(SN(20),THGY1),(SN(21),THGZ1),CBL 15500
7      (SN(22),THGX2),(SN(23),THGY2),(SN(24),THGZ2),CBL 15510
8      (SN(25),THGX3),(SN(26),THGY3),(SN(27),THGZ3),CBL 15520
9      (SN(28),THGX4),(SN(29),THGY4),(SN(30),THGZ4)CBL 15530
DIMENSION FTOP(3,3),FBOT(3,3)CBL 15540
COT(A)=1./TAN(A)CBL 15550
IW=6CBL 15560
DO 1001 I=1,3CBL 15570
DO 1001 J=1,3CBL 15580
SNU(I,J)=0CBL 15590
1001 SNUD(I,J)=0CBL 15600
DO 5102 I=1,10CBL 15610
DO 5102 J=1,10CBL 15620
5102 DUM(I,J)=0CBL 15630
IF(KODE(10).NE.1) GO TO 1000CBL 15640
C TERMS FOR UNSNUBBED SNUBBER EFFECTS (LCNG)CBL 15650
DO 1004 I=1,7CBL 15660
DO 1004 J=1,7CBL 15670
1004 DUM(I,J)=0CBL 15680
CALL DRCUSN(THETA)CBL 15690
DUM(1,3)= -2.*TUSNO*GZ1CBL 15700
DUM(1,4)= -2.*TUSNO*SIN(THGX1)CBL 15710
DUM(1,6)= 2.*GX1CBL 15720
DUM(2,3)= 2.*TUSNO*GX1CBL 15730
DUM(2,5)= -2.*TUSNO*SIN(THGZ1)CBL 15740
DUM(2,6)= 2.*GZ1CBL 15750
DUM(3,3)= (-SNLZ*DUM(1,3)+SNLX*DUM(2,3))/12.CBL 15760
DUM(3,4)= -SNUZ*DUM(1,4)/12.CBL 15770
DUM(3,5)= SNLX*DUM(2,5)/12.CBL 15780
DUM(3,6)= (-SNLZ*DUM(1,6)+SNLX*DUM(2,6))/12.CBL 15790
DUM(4,1)=(SIN(THGX1)/ALU)*12.CBL 15800
DUM(4,2)= (-GZ1*COT(THGX1)/ALL)*12.CBL 15810
DUM(4,3)= -SNUZ*SIN(THGX1)/ALL-SNUX*GZ1+CCT(THGX1)/ALUCBL 15820
DUM(4,4)= -1.CBL 15830
DUM(5,1)= (-GX1*COT(THGZ1)/ALL)*12.CBL 15840
DUM(5,2)= (SIN(THGZ1)/ALU)*12.CBL 15850
DUM(5,3)= SNLZ*GX1*COT(THGZ1)/ALU + SNLX*SIN(THGZ1)/ALUCBL 15860
DUM(5,5)= -1.CBL 15870
CALL DRC SN(THETA)CBL 15880
Q=.5*RHO*VO*VOCBL 15890
ALU1=ALU+1.CBL 15900
CALL STINT(Q,ALU1,0,1,1,TLSN1,NG)CBL 15910
IF(NG.NE.0) GO TO 5000CBL 15920
ALU2=ALU-1.CBL 15930
CALL STINT(Q,ALU2,0,1,1,TLSN2,NG)CBL 15940
IF(NG.EQ.0) GO TO 5001CBL 15950

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5000	WRITE(IW, 5002) NG, ALL, ALU, Q	CBL 15960
5002	FORMAT('ERROR IN TABLE 1-2, NG=', I2, 3X E10.3)	CBL 15970
	RETURN	CBL 15980
5001	CONTINUE	CBL 15990
	AKTU = (TUSN1 - TUSN2) / 2.	CBL 16000
	DUM(6, 6) = -1.	CBL 16010
	DUM(6, 7) = AKTU * 12.	CBL 16020
	DUM(7, 1) = -GX1	CBL 16030
	DUM(7, 2) = -GZ1	CBL 16040
	DUM(7, 3) = ((-SNLX + ALU * GX1) * GZ1 - (-SNLZ + ALL * GZ1) * GX1) / 12.	CBL 16050
	DUM(7, 7) = -1.	CBL 16060
	CALL MASH(3, 7)	CBL 16070
	DO 1005 I = 1, 3	CBL 16080
	DO 1005 J = 1, 3	CBL 16090
1005	FTOP(I, J) = DUM(I, J)	CBL 16100
	CALL DRCUSN(THETA)	CBL 16110
	DUM(1, 3) = -2. * TLSN0 * GZ3	CBL 16120
	DUM(1, 4) = -2. * TLSN0 * SIN(THGX3)	CBL 16130
	DUM(1, 6) = 2. * GX3	CBL 16140
	DUM(2, 3) = 2. * TLSN0 * GX3	CBL 16150
	DUM(2, 5) = -2. * TLSN0 * SIN(THGZ3)	CBL 16160
	DUM(2, 6) = 2. * GZ3	CBL 16170
	DUM(3, 3) = (SNLZ * DUM(1, 3) + SNLX * DUM(2, 3)) / 12.	CBL 16180
	DUM(3, 4) = SNLZ * DUM(1, 4) / 12.	CBL 16190
	DUM(3, 5) = SNLX * DUM(2, 5) / 12.	CBL 16200
	DUM(3, 6) = (SNLZ * DUM(1, 6) + SNLX * DUM(2, 6)) / 12.	CBL 16210
	DUM(4, 1) = (SIN(THGX3) / ALL) * 12.	CBL 16220
	DUM(4, 2) = (-GZ3 * COT(THGX3) / ALL) * 12.	CBL 16230
	DUM(4, 3) = SNLZ * SIN(THGX3) / ALL - SNLX * GZ3 * COT(THGX3) / ALL	CBL 16240
	DUM(4, 4) = -1.	CBL 16250
	DUM(5, 1) = (-GX3 * COT(THGZ3) / ALL) * 12.	CBL 16260
	DUM(5, 2) = (SIN(THGZ3) / ALL) * 12.	CBL 16270
	DUM(5, 3) = -SNLZ * GX3 * COT(THGZ3) / ALL + SNLX * SIN(THGZ3) / ALL	CBL 16280
	DUM(5, 5) = -1.	CBL 16290
	CALL DRCUSN(THETA)	CBL 16300
	ALL1 = ALL + 1.	CBL 16310
	CALL STINT(Q, ALL1, 0, 1, 1, TLSN1, NG)	CBL 16320
	IF(NG.NE.0) GO TO 5003	CBL 16330
	ALL2 = ALL - 1.	CBL 16340
	CALL STINT(Q, ALL2, 0, 1, 1, TLSN2, NG)	CBL 16350
	IF(NG.EQ.0) GO TO 5004	CBL 16360
5003	WRITE(IW, 5002) NG, ALL, ALU, Q	CBL 16370
	RETURN	CBL 16380
5004	CONTINUE	CBL 16390
	AKTL = (TLSN1 - TLSN2) / 2.	CBL 16400
	DUM(6, 6) = -1.	CBL 16410
	DUM(6, 7) = AKTL * 12.	CBL 16420
	DUM(7, 1) = -GX3	CBL 16430
	DUM(7, 2) = -GZ3	CBL 16440
	DUM(7, 3) = ((-SNLX + ALL * GX3) * GZ3 - (SNLZ + ALL * GZ3) * GX3) / 12.	CBL 16450
	DUM(7, 7) = -1.	CBL 16460
	CALL MASH(3, 7)	CBL 16470
	DO 1008 I = 1, 3	CBL 16480
	DO 1008 J = 1, 3	CBL 16490
1008	FBOT(I, J) = DUM(I, J)	CBL 16500

DO 1009 I=1,3	CBL 16510
DO 1009 J=1,3	CBL 16520
SNUD(I,J)=0	CBL 16530
1009 SNU(I,J)=FTOP(I,J)+FBOT(I,J)	CBL 16540
RETURN	CBL 16550
1000 IF(KODE(10).EQ.C) GO TO 1002	CBL 16560
C TERMS FOR SNUBRED SNUBBER EFFECTS(LONG)	CBL 16570
CALL DRC SN(THETA)	CBL 16580
DO 1006 I=1,7	CBL 16590
DO 1006 J=1,7	CBL 16600
1006 DUM(I,J)=0	CBL 16610
DUM(1,3)= -2.*TUSNO*GX1	CBL 16620
DUM(1,4)= -2.*TUSNO*SIN(THGX1)	CBL 16630
DUM(1,6)= 2.*GX1	CBL 16640
DUM(2,3)= 2.*TUSNO*GX1	CBL 16650
DUM(2,5)= -2.*TUSNO*SIN(THGZ1)	CBL 16660
DUM(2,6)= 2.*GZ1	CBL 16670
DUM(3,3)= (-SNLZ*DUM(1,3)+SNLX*DUM(2,3))/12.	CBL 16680
DUM(3,4)= -SNLZ*DUM(1,4)/12.	CBL 16690
DUM(3,5)= SNLX*DUM(2,5)/12.	CBL 16700
DUM(3,6)= (-SNLZ*DUM(1,6)+SNLX*DUM(2,6))/12.	CBL 16710
DUM(4,1)= (SIN(THGX1)/ALL)*12.	CBL 16720
DUM(4,2)= (-GZ1*COT(THGX1)/ALL)*12.	CBL 16730
DUM(4,3)= -SNUZ*SIN(THGX1)/ALL-SNLX*GX1*(CCT(THGX1)/ALL)	CBL 16740
DUM(4,4)= -1.	CBL 16750
DUM(5,1)= (-GX1*COT(THGZ1)/ALL)*12.	CBL 16760
DUM(5,2)= (SIN(THGZ1)/ALL)*12.	CBL 16770
DUM(5,3)= SNLZ*GX1*COT(THGZ1)/ALL + SNLX*SIN(THGZ1)/ALL	CBL 16780
DUM(5,5)= -1.	CBL 16790
DUM(6,6)= -1.	CBL 16800
DUM(6,7)= AKSNL*12.	CBL 16810
DUM(7,1)= -GX1	CBL 16820
DUM(7,2)= -GZ1	CBL 16830
DUM(7,3)= ((-SNLX+ALL*GX1)*GZ1-(-SNUZ+ALL*GZ1)*GX1)/12.	CBL 16840
DUM(7,7)= -1.	CBL 16850
DO 10 I=1,3	CBL 16860
DO 10 J=1,3	CBL 16870
10 SNUD(I,J)=DUM(I,6)*ADSNL*DUM(7,J)*12.	CBL 16880
CALL MASH(3,7)	CBL 16890
DO 1007 I=1,3	CBL 16900
DO 1007 J=1,3	CBL 16910
1007 FTOP(I,J)=DUM(I,J)	CBL 16920
DUM(1,3)= -2.*TUSNO*GX3	CBL 16930
DUM(1,4)= -2.*TUSNO*SIN(THGX3)	CBL 16940
DUM(1,6)= 2.*GX3	CBL 16950
DUM(2,3)= 2.*TUSNO*GX3	CBL 16960
DUM(2,5)= -2.*TUSNO*SIN(THGZ3)	CBL 16970
DUM(2,6)= 2.*GZ3	CBL 16980
DUM(3,3)= (SNLZ*DUM(1,3)+SNLX*DUM(2,3))/12.	CBL 16990
DUM(3,4)= SNLZ*DUM(1,4)/12.	CBL 17000
DUM(3,5)= SNLX*DUM(2,5)/12.	CBL 17010
DUM(3,6)= (SNLZ*DUM(1,6)+SNLX*DUM(2,6))/12.	CBL 17020
DUM(4,1)= (SIN(THGX3)/ALL)*12.	CBL 17030
DUM(4,2)= (-GZ3*COT(THGX3)/ALL)*12.	CBL 17040
DUM(4,3)= SNLZ*SIN(THGX3)/ALL - SNLX*GZ3*(CCT(THGX3)/ALL)	CBL 17050

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      DUM(4,4)= -1.                                CBL 17060
      DUM(5,1)= (-GX3*COT(THGZ3)/ALL)*12.          CBL 17070
      DJM(5,2)= (SIN(THGZ3)/ALL)*12.              CBL 17080
      DUM(5,3)= -SNLZ*GX3*COT(THGZ3)/ALL + SNLX*SIN(THGZ3)/ALL CBL 17090
      DUM(5,5)= -1.                                CBL 17100
      DUM(6,6)= -1.                                CBL 17110
      DUM(6,7)= AKSNL*12.                          CBL 17120
      DUM(7,1)= -GX3                                CBL 17130
      DUM(7,2)= -GZ3                                CBL 17140
      DUM(7,3)= ((-SNLX+ALL*GX3)*GZ3 - (SNLZ+ALL*GZ3)*GX3)/12. CBL 17150
      DUM(7,7)= -1.                                CBL 17160
      DO 20 I=1,3                                    CBL 17170
      DO 20 J=1,3                                    CBL 17180
20    SNUD(I,J)=SNUD(I,J)+DUM(I,6)*ADSNL*DUM(7,J)*12. CBL 17190
      CALL MASH(3,7)                                CBL 17200
      DO 1010 I=1,3                                  CBL 17210
      DO 1010 J=1,3                                  CBL 17220
1010  FBOT(I,J)=DUM(I,J)                            CBL 17230
      DO 1011 I=1,3                                  CBL 17240
      DO 1011 J=1,3                                  CBL 17250
1011  SNU(I,J)= FTOP(I,J)+FBOT(I,J)                  CBL 17260
      RETURN                                          CBL 17270
1002  DO 1003 I=1,3                                  CBL 17280
      DO 1003 J=1,3                                  CBL 17290
      SNU(I,J)=0                                      CBL 17300
1003  SNU(I,J)=0                                      CBL 17310
      RETURN                                          CBL 17320
      END                                            CBL 17330
      SUBROUTINE DRC SN(THETA)                        CBL 17340
      COMMON /DAT/AERO(150),AEROP(50),KODE(20),LL    CBL 17350
      COMMON /SNUBR/SNU(3,3),SN(30),THUSN,THLSN,SNUD(3,3) CBL 17360
      EQUIVALENCE(AERO(105), SNLX), (AERO(106), SNLY), (AERC(107), SNUZ), CBL 17370
1      (AERO(108), SNLX), (AERO(109), SNLY), (AERC(110), SNLZ), CBL 17380
2      (AERO(111), SNLST), (AERO(112), SNLWL), (AERC(113), SNUBL), CBL 17390
3      (AERO(114), SNLST), (AERO(115), SNLWL), (AERC(116), SNLBL), CBL 17400
4      (AERO(117), TUSNO), (AERC(118), TLSNC), (AERC(119), AKSNU), CBL 17410
5      (AERO(120), AKSNL),                          CBL 17420
6      (AERO(76), WLCR), (AERC(77), STACF), (AERC(78), BLCR) CBL 17430
      EQUIVALENCE (SN( 1), GX1), (SN( 2), GY1), (SN( 3), GZ1), CBL 17440
1      (SN( 4), GX2), (SN( 5), GY2), (SN( 6), GZ2), CBL 17450
2      (SN( 7), GX3), (SN( 8), GY3), (SN( 9), GZ3), CBL 17460
3      (SN(10), GX4), (SN(11), GY4), (SN(12), GZ4), CBL 17470
4      (SN(13), THU), (SN(14), THL), (SN(15), ALU), CBL 17480
5      (SN(16), ALL),                                CBL 17490
6      (SN(19), THGX1), (SN(20), THGY1), (SN(21), THGZ1), CBL 17500
7      (SN(22), THGX2), (SN(23), THGY2), (SN(24), THGZ2), CBL 17510
8      (SN(25), THGX3), (SN(26), THGY3), (SN(27), THGZ3), CBL 17520
9      (SN(28), THGX4), (SN(29), THGY4), (SN(30), THGZ4) CBL 17530
C  CALCULATION OF SNUBBER CABLE DIRECTION COSINES CBL 17540
      XB1= (STACR-SNLST)*COS(THETA)-(WLCR-SNLWL)*SIN(THETA) CBL 17550
      ZB1= (WLCR-SNUWL)*COS(THETA)+(STACR-SNLST)*SIN(THETA) CBL 17560
      XB2= XB1                                        CBL 17570
      ZB2= ZB1                                        CBL 17580
      XB3= (STACR-SNLST)*COS(THETA)-(WLCR-SNLWL)*SIN(THETA) CBL 17590
      ZB3= (WLCR-SNLWL)*COS(THETA)+(STACR-SNLST)*SIN(THETA) CBL 17600

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XB4= XB3                                CBL 17610
ZB4=ZB3                                CBL 17620
DX 1= XB1+SNUX                          CBL 17630
DY 1= -SNUBL+SNLY                      CBL 17640
DZ 1= ZB1+SNUZ                          CBL 17650
DX 2= DX1                               CBL 17660
DY 2= SNUBL-SNUY                       CBL 17670
DZ 2= DZ1                               CBL 17680
DX 3= XB3+SNLX                          CBL 17690
DY 3= SNLBL-SNL Y                      CBL 17700
DZ 3= ZB3-SNLZ                         CBL 17710
DX 4= DX3                               CBL 17720
DY 4= -SNLBL+SNLY                     CBL 17730
DZ 4= DZ3                               CBL 17740
ALUSQ= DX1**2 + DY1**2 + DZ1**2        CBL 17750
ALU = SQRT(ALUSQ)                      CBL 17760
ALLSQ = DX3**2 + DY3**2 + DZ3**2      CBL 17770
ALL = SQRT(ALLSQ)                     CBL 17780
GX 1 = DX1/ALU                         CBL 17790
GY 1 = DY1/ALU                         CBL 17800
GZ 1 = DZ1/ALU                         CBL 17810
GX 2 = DX2/ALU                         CBL 17820
GY 2 = DY2/ALU                         CBL 17830
GZ 2 = DZ2/ALU                         CBL 17840
GX 3 = DX3/ALL                         CBL 17850
GY 3 = DY3/ALL                         CBL 17860
GZ 3 = DZ3/ALL                         CBL 17870
GX 4 = DX4/ALL                         CBL 17880
GY 4 = DY4/ALL                         CBL 17890
GZ 4 = DZ4/ALL                         CBL 17900
DO 1 I=19,30                           CBL 17910
J=I-18                                 CBL 17920
1 SN(I)=ARCOS(SN(J))                   CBL 17930
RETURN                                  CBL 17940
END                                     CBL 17950
SUBROUTINE DRCLSN(THETA)                CBL 17960
COMMON/DAT/AERO(150),AEROP(50),KODE(20),LL CBL 17970
COMMON/SNUBB/SNL(3,3),SN(30),THLSN,THLSN,SNLC(3,3) CBL 17980
EQUIVALENCE(AERO(105),SNLX),(AERO(106),SNLY),(AERO(107),SNUZ), CBL 17990
1 (AERO(108),SNLX),(AERO(109),SNLY),(AERO(110),SNLZ), CBL 18000
2 (AERO(111),SNLST),(AERO(112),SNLML),(AERO(113),SNUBL), CBL 18010
3 (AERO(114),SNLST),(AERO(115),SNLML),(AERO(116),SNLBL), CBL 18020
4 (AERO(117),TUSNO),(AERO(118),TUSNC),(AERO(119),AKSNU), CBL 18030
5 (AERO(120),AKSNL), CBL 18040
6 (AERO(76),WLCR),(AERO(77),STACF),(AERO(78),BLCR) CBL 18050
EQUIVALENCE (SN( 1), GX1),(SN( 2), GY1),(SN( 3), GZ1), CBL 18060
1 (SN( 4), GX2),(SN( 5), GY2),(SN( 6), GZ2), CBL 18070
2 (SN( 7), GX3),(SN( 8), GY3),(SN( 9), GZ3), CBL 18080
3 (SN(10), GX4),(SN(11), GY4),(SN(12), GZ4), CBL 18090
4 (SN(13), THU),(SN(14), THL),(SN(15), ALU), CBL 18100
5 (SN(16), ALL), CBL 18110
6 (SN(19),THGX1),(SN(20),THGY1),(SN(21),THGZ1), CBL 18120
7 (SN(22),THGX2),(SN(23),THGY2),(SN(24),THGZ2), CBL 18130
8 (SN(25),THGX3),(SN(26),THGY3),(SN(27),THGZ3), CBL 18140
9 (SN(28),THGX4),(SN(29),THGY4),(SN(30),THGZ4) CBL 18150

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C    CALCULATION FOR EFFECTIVE DIRECTION COSINES FOR UNSNUBBED CASE      CBL 18160
      AYL = SNLBL-(BLCR+SNLY)      CBL 18170
      AZL = -SNLWL-(WLCP+SNLZ+SNLX*SIN(THETA))      CBL 18180
      AYU = SNURL-(RLCR+SNUY)      CBL 18190
      AZU = SNUWL-(WLCP+SNUZ-SNLX*SIN(THETA))      CBL 18200
      THU= ATAN(AZU/AYU)      CBL 18210
      THL= ATAN(AZL/AYL)      CBL 18220
      ALU=AYU/(SIN(THUSN)*COS(THL))      CBL 18230
      GX1S= -COS(THUSN)      CBL 18240
      GY1S= -AYU/ALU      CBL 18250
      GZ1S= -AZU/ALU      CBL 18260
      GX1 = GX1S*COS(THETA)-GZ1S*SIN(THETA)      CBL 18270
      GY1 = GY1S      CBL 18280
      GZ1 = GZ1S*COS(THETA)+GX1S*SIN(THETA)      CBL 18290
      GX2 = GX1      CBL 18300
      GY2 = -GY1      CBL 18310
      GZ2 = GZ1      CBL 18320
      ALL=AYL/(SIN(THLSN)*COS(THL))      CBL 18330
      GX3S= -COS(THLSN)      CBL 18340
      GY3S= AYL/ALL      CBL 18350
      GZ3S= AZL/ALL      CBL 18360
      GX3 = GX3S*COS(THETA)-GZ3S*SIN(THETA)      CBL 18370
      GY3 = GY3S      CBL 18380
      GZ3 = GZ3S*COS(THETA)+GX3S*SIN(THETA)      CBL 18390
      GX4 = GX3      CBL 18400
      GY4 = -GY3      CBL 18410
      GZ4 = GZ3      CBL 18420
      DO 1 I=19,30      CBL 18430
      J=I-19      CBL 18440
1    SN(I)=ARCOS(SN(J))      CBL 18450
      RETURN      CBL 18460
      END      CBL 18470
      SUBROUTINE RITE      CBL 18480
      COMMON/DAT/AERO(150),AEROP(50),KODE(20),LL      CBL 18490
      IW=6      CBL 18500
      IF(KODE(6).GT.1) GO TO 1      CBL 18510
      WRITE(IW,100)      CBL 18520
100    FORMAT(15X,'FRONT CABLE VERTICAL,REAR CABLE HORIZONTAL')      CBL 18530
      GO TO 4      CBL 18540
      1 IF(KODE(6).GT.2) GO TO 2      CBL 18550
      WRITE(IW,200)      CBL 18560
200    FORMAT(15X,'FRONT CABLE HORIZONTAL,REAR CABLE VERTICAL')      CBL 18570
      GO TO 4      CBL 18580
      2 IF(KODE(6).GT.3) GO TO 3      CBL 18590
      WRITE(IW,300)      CBL 18600
300    FORMAT(15X,'BOTH CABLES VERTICAL')      CBL 18610
      GO TO 4      CBL 18620
      3 WRITE(IW,400)      CBL 18630
400    FORMAT(15X,'BOTH CABLES HORIZONTAL')      CBL 18640
      4 CONTINUE      CBL 18650
      IF(KODE(10).EQ.0) GO TO 5      CBL 18660
      IF(KODE(10).EQ.1) GO TO 6      CBL 18670
      WRITE(IW,500)      CBL 18680
500    FORMAT(15X,'SNUBBERS SNUBBED')      CBL 18690
      GO TO 7      CBL 18700

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5	WRITE(IW,600)	CBL 18710
6	FORMAT(15X, 'NO SNUBBERS')	CBL 18720
	GO TO 7	CBL 18730
6	WRITE(IW,700)	CBL 18740
700	FORMAT(15X, 'SNUBBERS UNSNUBBED')	CBL 18750
7	CONTINUE	CBL 18760
	IF(KODE(11)).EQ.0) GO TO 8	CBL 18770
	WRITE(IW,800)	CBL 18780
800	FORMAT(15X, 'LIFT/ANTI-LIFT CABLE IN')	CBL 18790
	GO TO 9	CBL 18800
8	WRITE(IW,900)	CBL 18810
900	FORMAT(15X, 'NO LIFT/ANTI-LIFT CABLE')	CBL 18820
9	CONTINUE	CBL 18830
	RETURN	CBL 18840
	END	CBL 18850
	SUBROUTINE STINT(A1,A2,A3,MINTBL,MAXTBL,FACT,NG)	CBL 18860
	EQUIVALENCE (X(1),NUMPTS(1))	CBL 18870
	COMMON NUMPTS(1)	CBL 18880
	DIMENSION X(1)	CBL 18890
	IZ=NUMPTS(1)/3	CBL 18900
70	IF(MINTBL-MAXTBL) 71,71,110	CBL 18910
71	DO 73 II=MINTBL,MAXTBL	CBL 18920
	NJ=NUMPTS(II)+1	CBL 18930
	IF(A3-X(NJ))72,74,73	CBL 18940
72	IF(II-MINTBL) 110,112,75	CBL 18950
73	CONTINUE	CBL 18960
	GO TO 112	CBL 18970
5	IK = 1	CBL 18980
	IL = 2	CBL 18990
	NM=NJ	CBL 19000
101	DO 97 IF=IK,IL	CBL 19010
	NJ =NUMPTS(II)+1	CBL 19020
	NI = IZ+II	CBL 19030
	IO =NUMPTS(NI)	CBL 19040
	IP = IO+NJ	CBL 19050
	DO 77 IQ=1,IO	CBL 19060
	NN= NJ+IQ	CBL 19070
	IF (A1-X(NN))76,78,77	CBL 19080
76	IF(IQ-1) 110,112,79	CBL 19090
77	CONTINUE	CBL 19100
	GO TO 112	CBL 19110
78	IG =-1	CBL 19120
	GO TO 80	CBL 19130
79	IG =+1	CBL 19140
80	NI=NI+IZ	CBL 19150
	IB = NUMPTS(NI)	CBL 19160
	DO 82 IA=1,IB	CBL 19170
	NS=IP+IA	CBL 19180
	IF (A2-X(NS))81,83,82	CBL 19190
81	IF(IA-1) 110,112,84	CBL 19200
82	CONTINUE	CBL 19210
	GO TO 112	CBL 19220
83	IH =-1	CBL 19230
	GO TO 85	CBL 19240
84	IH =+1	CBL 19250

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85 NE=IP+IB+IQ+IO*IA-IO                                CBL 19260
   NR=NE-IO                                              CBL 19270
   IF(IG+IH) 66,88,91                                   CBL 19280
86 IF (X(NE)-99998.5E9)87,113,113                      CBL 19290
87 FCT = X(NE)                                          CBL 19300
   GO TO 95                                              CBL 19310
88 IF(IG) 89,110,93                                     CBL 19320
89 IF(AMAX1(X(NE),X(NR))-99998.5E9)90,113,113          CBL 19330
90 FCT =X(NE)-((X(NS)-A2)*(X(NE)-X(NR))/(X(NS)-X(NS-1))) CBL 19340
   GO TO 95                                              CBL 19350
91 IF(AMAX1(X(NE),X(NR),X(NE-1),X(NR-1))-99998.5E9)92,113,113 CBL 19360
92 FCT = ((X(NS)-A2)*((X(NN)-A1)*X(NR-1)-(X(NN-1)-A1)*X(NR) CBL 19370
   1)-(X(NS-1)-A2)*((X(NN)-A1)*X(NE-1)-(X(NN-1)-A1)*X(NE))) CBL 19380
   2/((X(NS)-X(NS-1))*(X(NN)-X(NN-1)))                CBL 19390
   GO TO 95                                              CBL 19400
93 IF(AMAX1(X(NE),X(NE-1))-99998.5E9) 94,113,113      CBL 19410
94 FCT = X(NE)-((X(NN)-A1)*(X(NE)-X(NE-1))/(X(NN)-X(NN-1))) CBL 19420
95 GO TO (66,88,99),IF                                  CBL 19430
96 DUMSTG =FCT                                          CBL 19440
97 II =II-1                                             CBL 19450
98 FCT =DUMSTG-((X(NM)-A3)*(DUMSTG-FCT)/(X(NN)-X(NJ))) CBL 19460
99 RETURN                                              CBL 19470
74 IK =3                                               CBL 19480
   IL =3                                               CBL 19490
   GO TO 101                                             CBL 19500
110 NG =2                                              CBL 19510
   GO TO 99                                             CBL 19520
   2 NG =3                                              CBL 19530
   GO TO 99                                             CBL 19540
113 NG =4                                              CBL 19550
   GO TO 99                                             CBL 19560
END                                                    CBL 19570
SUBROUTINE TABIN(NUMTBL,NZ,NG)                          CBL 19580
COMMON NUMPTS(1)                                       CBL 19590
COMMON /TABOUT/ NIMTBL,ISQ                             CBL 19600
DIMENSION XUMPTS(1)                                    CBL 19610
INTEGER*2 LABEL(27)                                   CBL 19620
EQUIVALENCE (XUMPTS(1),NUMPTS(1)),(DUMMY(1),MUMMY)   CBL 19630
DIMENSION DUMMY(10)                                    CBL 19640
MCR=0                                                  CBL 19650
10 IZ=IABS(NZ)                                         CBL 19660
NUNIT=5                                                CBL 19670
IF(NZ.LT.0) NUNIT=8                                   CBL 19680
NIMTBL = NUMTBL                                       CBL 19690
NG=0                                                  CBL 19700
NUMPTS(1)=IZ+IZ+IZ                                   CBL 19710
102 READ(NUNIT,57) K, L1N, L2N, LABEL, ISEQ          CBL 19720
   IF(MCR.EQ.0) GO TO 3                                CBL 19730
   4 WRITE(6,1) K,L1N,L2N,LABEL,ISEQ                  CBL 19740
   1 FORMAT(3I5,10X,27A2,I46)                         CBL 19750
57  FORMAT(8X,I4,2I2,27A2,I2)                         CBL 19760
   3 IF(ISEQ) 69,58,69                                 CBL 19770
   IF(K) 99, 99, 59                                   CBL 19780
   9 M = IZ + NIMTBL                                  CBL 19790
   NUMPTS(M) = L1N                                    CBL 19800

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M = M + IZ	CBL 19810
NUMPTS(M) = L2N	CBL 19820
IF(NUMTBL-NIMTBL)17,70,17	CBL 19830
17 NUMPTS(NIMTBL) = MUMMY	CBL 19840
70 N1 = (L1N-1) / 9 + 1	CBL 19850
DO 68 IS = 1,N1	CBL 19860
L3 = (IS-1) * 9 + 1	CBL 19870
IF (IS-N1) 60, 61, 60	CBL 19880
60 L4 = L3 + 8	CBL 19890
GO TO 62	CBL 19900
61 L4 = L1N	CBL 19910
62 L5 = NUMPTS(NIMTBL) + 1	CBL 19920
L6 = L5 + L3	CBL 19930
L7 = L5 + L4	CBL 19940
JJ = 0	CBL 19950
LM = L5 + L1N	CBL 19960
LN = LM + L2N	CBL 19970
63 READ(NUNIT,64) (DUMMY(K),K=1,10), ISEQ	CBL 19980
64 FORMAT (10E7.0,I2)	CBL 19990
IF(MCP.EQ.0) GO TO 5	CBL 20000
6 WRITE(6,2)DUMMY,ISEQ	CBL 20010
2 FORMAT(10E12.4,I5)	CBL 20020
5 XUMPTS(L5)= DUMMY(1)	CBL 20030
K = 2	CBL 20040
DO 65 J = L6,L7	CBL 20050
XUMPTS(J) = DUMMY(K)	CBL 20060
65 K = K+1	CBL 20070
ISQQ=(IS-1)*(L2N+1)+JJ+1	CBL 20080
IF(ISEQ-ISQQ) 69,66,69	CBL 20090
66 L6 = LN + L3	CBL 20100
L7 = LN + L4	CBL 20110
L5 = LM + 1 + JJ	CBL 20120
IF (JJ-L2N) 67, 66, 69	CBL 20130
67 JJ = JJ + 1	CBL 20140
LN = LN + L1N	CBL 20150
GO TO 63	CBL 20160
68 CONTINUE	CBL 20170
109 MUMMY = NUMPTS(NIMTBL) + (L1N+1) * (L2N+1)	CBL 20180
109 NIMTBL = NIMTBL + 1	CBL 20190
GO TO 102	CBL 20200
69 NG = 1	CBL 20210
99 RETURN	CBL 20220
END	CBL 20230
SUBROUTINE STINT1(A1,A2,A3,MINTBL,MAXTBL,FCT,NG)	CBL 20240
EQUIVALENCE (X(1),NUMPTS(1))	CBL 20250
COMMON/TAB1/NUMPTS(1)	CBL 20260
DIMENSION X(1)	CBL 20270
IZ=NUMPTS(1)/3	CBL 20280
70 IF(MINTBL-MAXTBL)71,71,110	CBL 20290
71 DO 73 II=MINTBL,MAXTBL	CBL 20300
NJ=NUMPTS(II)+1	CBL 20310
IF(A3-X(NJ))72,74,73	CBL 20320
72 IF(II-MINTBL) 110,112,75	CBL 20330
3 CONTINUE	CBL 20340
GO TO 112	CBL 20350

75	IK = 1	CBL 20360
	IL = 2	CBL 20370
	NM = NJ	CBL 20380
101	DO 97 IF = IK, IL	CBL 20390
	NJ = NUMPTS(II) + 1	CBL 20400
	NI = IZ + II	CBL 20410
	ID = NUMPTS(NI)	CBL 20420
	IP = IO + NJ	CBL 20430
	DO 77 IQ = 1, IO	CBL 20440
	NN = NJ + IO	CBL 20450
	IF (A1 - X(NN)) 76, 78, 77	CBL 20460
76	IF (IQ - 1) 110, 112, 79	CBL 20470
77	CONTINUE	CBL 20480
	GO TO 112	CBL 20490
78	IG = -1	CBL 20500
	GO TO 80	CBL 20510
79	IG = +1	CBL 20520
80	NI = NI + IZ	CBL 20530
	IR = NUMPTS(NI)	CBL 20540
	DO 82 IA = 1, IR	CBL 20550
	NS = IP + IA	CBL 20560
	IF (A2 - X(NS)) 81, 83, 82	CBL 20570
81	IF (IA - 1) 110, 112, 84	CBL 20580
82	CONTINUE	CBL 20590
	GO TO 112	CBL 20600
83	IH = -1	CBL 20610
	GO TO 85	CBL 20620
4	IH = +1	CBL 20630
85	NE = IP + IR + IQ + ID * IA - IO	CBL 20640
	NR = NE - IO	CBL 20650
	IF (IG + IH) 86, 88, 91	CBL 20660
86	IF (X(NE) - 99998.5E9) 87, 113, 113	CBL 20670
87	FCT = X(NE)	CBL 20680
	GO TO 95	CBL 20690
88	IF (IG) 89, 110, 93	CBL 20700
89	IF (AMAX1(X(NE), X(NR)) - 99998.5E9) 90, 113, 113	CBL 20710
90	FCT = X(NE) - (X(NS) - A2) * (X(NE) - X(NR)) / (X(NS) - X(NS-1))	CBL 20720
	GO TO 95	CBL 20730
91	IF (AMAX1(X(NE), X(NR), X(NE-1), X(NR-1)) - 99998.5E9) 92, 113, 113	CBL 20740
92	FCT = ((X(NS) - A2) * ((X(NN) - A1) * X(NR-1) - (X(NN-1) - A1) * X(NR))	CBL 20750
	1) - (X(NS-1) - A2) * ((X(NN) - A1) * X(NE-1) - (X(NN-1) - A1) * X(NE)))	CBL 20760
	2 / ((X(NS) - X(NS-1)) * (X(NN) - X(NN-1)))	CBL 20770
	GO TO 95	CBL 20780
93	IF (AMAX1(X(NE), X(NE-1)) - 99998.5E9) 94, 113, 113	CBL 20790
94	FCT = X(NE) - (X(NN) - A1) * (X(NE) - X(NE-1)) / (X(NN) - X(NN-1))	CBL 20800
95	GO TO (96, 98, 99), IF	CBL 20810
96	DUMSTG = FCT	CBL 20820
97	II = II - 1	CBL 20830
98	FCT = DUMSTG - (X(NM) - A3) * (DUMSTG - FCT) / (X(NM) - X(NJ))	CBL 20840
99	RETURN	CBL 20850
74	IK = 3	CBL 20860
	IL = 3	CBL 20870
	GO TO 101	CBL 20880
0	NG = 2	CBL 20890
	GO TO 99	CBL 20900

112	NG = 3	CBL 20910
	GO TO 99	CBL 20920
3	NG = 4	CBL 20930
	GO TO 99	CBL 20940
	END	CBL 20950
	SUBROUTINE TABIN1(NUMTBL,NZ,NG)	CBL 20960
	COMMON/TAB1/NUMPTS(1)	CBL 20970
	COMMON /TABOUI/ NIMTBL,ISEQ	CBL 20980
	DIMENSION XUMPTS(1)	CBL 20990
	INTEGER*2 LABEL(27)	CBL 21000
	EQUIVALENCE (XUMPTS(1),NUMPTS(1)),(DUMMY(1),MUMMY)	CBL 21010
	DIMENSION DUMMY(10)	CBL 21020
	MCR=C	CBL 21030
10	IZ = IABS(NZ)	CBL 21040
	NUNIT=5	CBL 21050
	IF(NZ.LT.0) NUNIT=8	CBL 21060
	NIMTBL = NUMTBL	CBL 21070
	NG=0	CBL 21080
	NUMPTS(1)=IZ+IZ+IZ	CBL 21090
102	READ(NUNIT,57) K, L1N, L2N, LABEL, ISEQ	CBL 21100
	IF(MCR.EQ.0) GO TO 3	CBL 21110
4	WRITE(6,1) K,L1N,L2N,LABEL,I SEQ	CBL 21120
1	FORMAT(3I5, 10X,27A2,I46)	CBL 21130
57	FORMAT(8X14,2I2,27A2,I2)	CBL 21140
3	IF(ISEQ) 69,58,69	CBL 21150
58	IF(K) 99, 99, 59	CBL 21160
59	M = IZ + NIMTBL	CBL 21170
	NUMPTS(M) = L1N	CBL 21180
	M = M + IZ	CBL 21190
	NUMPTS(M) = L2N	CBL 21200
	IF(NUMTBL-NIMTBL)17,70,17	CBL 21210
17	NUMPTS(NIMTBL) = MUMMY	CBL 21220
70	N1 = (L1N-1) / 5 + 1	CBL 21230
	DO 68 IS = 1,N1	CBL 21240
	L3 = (IS-1) * 5 + 1	CBL 21250
	IF (IS-N1) 60, 61, 60	CBL 21260
60	L4 = L3 + 6	CBL 21270
	GO TO 62	CBL 21280
61	L4 = L1N	CBL 21290
62	L5 = NUMPTS(NIMTBL) + 1	CBL 21300
	L6 = L5 + L3	CBL 21310
	L7 = L5 + L4	CBL 21320
	JJ = 0	CBL 21330
	LM = L5 + L1N	CBL 21340
	LN = LM + L2N	CBL 21350
63	READ(NUNIT,64) (DUMMY(K),K=1,10), ISEQ	CBL 21360
64	FORMAT (10E7.0,I2)	CBL 21370
	IF(MCR.EQ.0) GO TO 5	CBL 21380
6	WRITE(6,2)DUMMY,I SEQ	CBL 21390
2	FORMAT(10E12.4,I5)	CBL 21400
5	XUMPTS(L5)= DUMMY(1)	CBL 21410
	K = 2	CBL 21420
	DO 65 J = L6,L7	CBL 21430
	XUMPTS(J) = DUMMY(K)	CBL 21440
65	K = K+1	CBL 21450

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      ISOQ=( IS-1)*(L2N+1)+JJ+1
      IF( ISEQ-ISOQ) 69,66,69
      L6 = LN + L3
      L7 = LN + L4
      L5 = LM + 1 + JJ
      IF (JJ-L2N) 67, 68, 69
67  JJ = JJ + 1
      LN = LN + L1N
      GO TO 63
68  CONTINUE
109  MUMMY = NUMPTS(NIMTBL) + (L1N+1) * (L2N+1)
108  NIMTBL = NIMTBL + 1
      GO TO 102
69  NG = 1
99  RETURN
      END
      SUBROUTINE FRIC(IX)
      COMMON/DAT/AERO(150),AEROP(50),KODE(20)
      COMMON/ROUGH/FRIC(3,6)
      EQUIVALENCE (AERO(96),COU),(AERO(104),CAF)
      DO 1 I=1,3
      DO 1 J=1,6
      1  FRIC(I,J)=0.
      IF(CMP.EQ.0..AND.COUEQ.0.)RETURN
      IND=KODE(6)
      IF(IX.NE.0)GO TO 2
C  LONGITUDINAL PULLEY FRICTION COMPUTATION
      GO TO(10,11,12,13),IND
      10 CALL FRVT(1)
      RETURN
      11 CALL FRVT(3)
      RETURN
      12 CALL FRVT(1)
      CALL FRVT(3)
      13 RETURN
C  LATERAL DIRECTIONAL FRICTION COMPUTATION
      2 GO TO(20,21,22,23),IND
      20 CALL FRF7(3)
      RETURN
      21 CALL FRFZ(1)
      22 RETURN
      23 CALL FRF7(1)
      CALL FRFZ(3)
      RETURN
      END
      SUBROUTINE FRVT(IC)
C  COMPUTES THE FRICT. EFFECT OF THE VERT PULLEYS ON THE LONG. DYN.
      COMMON/DAT/AERO(150),AEROP(50),KODE(20)
      COMMON/PLYCHA/RTD,XLGTH(5),ADC(5,3),ARM(5,3),TF,TLFT,TF
      COMMON/ROUGH/FRIC(3,6)
      EQUIVALENCE (AERO(90),RVF),(AERO(92),RVF),(AERO(96),CCU),
      1(AERO(104),CMP)
      DIMENSION DT1(3),DT2(3)
      IF( IC.EQ.3)GO TO 1
      TENS=TF

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CBL 21460
 CBL 21470
 CBL 21480
 CBL 21490
 CBL 21500
 CBL 21510
 CBL 21520
 CBL 21530
 CBL 21540
 CBL 21550
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 CBL 21880
 CBL 21890
 CBL 21900
 CBL 21910
 CBL 21920
 CBL 21930
 CBL 21940
 CBL 21950
 CBL 21960
 CBL 21970
 CBL 21980
 CBL 21990
 CBL 22000

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      RAD=RVF/12.                                CBL 22010
      AVX=(ADC(2,1)-ADC(1,1))/2.                  CBL 22020
      CAX=COS(AVX)                                CBL 22030
      CAZ=SIN(AVX)                                CBL 22040
      GO TO 2                                      CBL 22050
1    TENS=TR                                       CBL 22060
      RAD=RVR/12.                                CBL 22070
      AVX=3.14159+(ADC(4,1)-ADC(3,1))/2.          CBL 22080
      CAX=COS(AVX)                                CBL 22090
      CAZ=SIN(AVX)                                CBL 22100
2    ARMX=(ARM(IC,1)+ARM(IC+1,1))/24.             CBL 22110
      ARMZ=(ARM(IC+1,3)-ARM(IC,3))/24.            CBL 22120
      ENORX=TENS*COS(ADC(IC,1))                   CBL 22130
      ENORZ=TENS*(1.+COS(ADC(IC,3)))               CBL 22140
      ENORM=SQRT(ENORX**2+ENORZ**2)                CBL 22150
      CMPP=CMPP/ENORM                             CBL 22160
      FACU=CMPP*ENORM/RAD**2                      CBL 22170
      ENORX=TENS*COS(ADC(IC+1,1))                 CBL 22180
      ENORZ=TENS*(1.+COS(ADC(IC+1,3)))             CBL 22190
      ENORM=SQRT(ENORX**2+ENORZ**2)                CBL 22200
      CMPP=CMPP/ENORM                             CBL 22210
      FACL=CMPP*ENORM/RAD**2                      CBL 22220
      FACT=4.*COU/(3.14159*RAD**2)                CBL 22230
      CALL DLGTH(CX,CZ,CT,IC,0)                   CBL 22240
      CALL DLGTH(CXP,CZP,CTP,IC+1,0)              CBL 22250
      DT1(1)=FACT*(CXP-CX)                        CBL 22260
      DT1(2)=FACT*(CZP-CZ)                        CBL 22270
      DT1(3)=FACT*(CTP-CT)                        CBL 22280
      DT2(1)=FACL*CXP-FACU*CX                     CBL 22290
      DT2(2)=FACL*CZP-FACU*CZ                     CBL 22300
      DT2(3)=FACL*CTP-FACL*CT                     CBL 22310
      DO 3 I=1,3                                   CBL 22320
      FRIC(1,I)=FRIC(1,I)+DT1(I)*CAX              CBL 22330
      FRIC(1,I+3)=FRIC(1,I+3)+DT2(I)*CAX          CBL 22340
      FRIC(2,I)=FRIC(2,I)+DT1(I)*CAZ              CBL 22350
      FRIC(2,I+3)=FRIC(2,I+3)+DT2(I)*CAZ          CBL 22360
      FRIC(3,I)=FRIC(3,I)+DT1(I)*RAD+DT1(I)*CAX*ARMZ-CT1(I)*CAZ*ARMX CBL 22370
      FRIC(3,I+3)=FRIC(3,I+3)+DT2(I)*RAD+DT2(I)*CAX*ARMZ-DT2(I)*CAZ*ARMX CBL 22380
3    CONTINUE                                     CBL 22390
      RETURN                                       CBL 22400
      END                                         CBL 22410
      SUBROUTINE FRHZ(IC)                         CBL 22420
C    COMPUTES THE FRICT. EFFECT OF THE HORZ PULLEYS ON THE LAT. DIR. DYN. CBL 22430
      COMMON/DAT/AERO(150),AEROP(50),KODE(20)      CBL 22440
      COMMON/PLYCHA/RTD,XLGTH(5),ADC(5,3),ARM(5,3),TR,TLFT,TF CBL 22450
      COMMON/ROUGH/FRIC(3,6)                     CBL 22460
      EQUIVALENCE (AERO(91),RHF),(AERO(93),RHF),(AEFC(96),COU), CBL 22470
      1(AERO(104),CMP)                             CBL 22480
      DIMENSION DT1(3),DT2(3)                     CBL 22490
      IF(IC.EQ.3)GO TO 1                          CBL 22500
      TENS=TF                                       CBL 22510
      RAD=RHF/12.                                  CBL 22520
      GO TO 2                                       CBL 22530
1    TENS=TR                                       CBL 22540
      RAD=RFR/12.                                  CBL 22550

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2 ENORX=TENS*COS(ADC(IC,1))                                CBL 22560
  ENORY=TENS*(1.+COS(ADC(IC,2)))                            CBL 22570
  ENORM=SQRT(ENORY*ENORY+ENORX+ENORX)                       CBL 22580
  CMPP=CMPP/ENORM                                           CBL 22590
  FACL=CMPP*ENORM/RAD**2                                    CBL 22600
  FACT=4.*COL/(3.14159*RAD**2)                             CBL 22610
  CALL DLGTH(CY,CPSI,CPHI,IC,1)                             CBL 22620
  CALL DLGTH(CYP,CPSIP,CPHIP,IC+1,1)                       CBL 22630
  DT1(1)=FACT*(CY-CYP)                                     CBL 22640
  DT1(2)=FACT*(CPSI-CPSIP)                                 CBL 22650
  DT1(3)=FACT*(CPHI-CPHIP)                                 CBL 22660
  DT2(1)=FACL*(CY-CYP)                                     CBL 22670
  DT2(2)=FACL*(CPSI-CPSIP)                                 CBL 22680
  DT2(3)=FACL*(CPHI-CPHIP)                                 CBL 22690
  DO 3 I=1,3                                               CBL 22700
    FRIC(1,I)=FRIC(1,I)+DT1(I)*COS(ADC(IC,2))              CBL 22710
    FRIC(1,I+3)=FRIC(1,I+3)+DT2(I)*COS(ADC(IC,2))          CBL 22720
    FRIC(2,I)=FRIC(2,I)+DT1(I)*RAD-DT1(I)*CCS(ACC(IC,1))*ARM(IC,2) CBL 22730
    1/12.+DT1(I)*COS(ADC(IC,2))*ARM(IC,1)/12.              CBL 22740
    FRIC(2,I+3)=FRIC(2,I+3)+DT2(I)*RAD-DT2(I)*CCS(ACC(IC,1))*ARM(IC,2) CBL 22750
    1/12.+DT2(I)*COS(ADC(IC,2))*ARM(IC,1)/12.              CBL 22760
    FRIC(3,I)=FRIC(3,I)+DT1(I)*RAD+DT1(I)*CCS(ACC(IC,3))*ARM(IC,2) CBL 22770
    1/12.-ARM(IC,3)/12.*DT1(I)*COS(ADC(IC,2))              CBL 22780
    FRIC(3,I+3)=FRIC(3,I+3)+DT2(I)*RAD+DT2(I)*CCS(ACC(IC,3))*ARM(IC,2) CBL 22790
    1/12.-ARM(IC,3)/12.*DT2(I)*COS(ADC(IC,2))              CBL 22800
3 CONTINUE                                                CBL 22810
  RETURN                                                  CBL 22820
  END                                                    CBL 22830
C THIS IS A SINGLE PRECISION VERSION OF THE LRC MATRIX    CBL 22840
C MATRIX REDUCTION AND THE IBM ROOT FINDING ROUTINE      CBL 22850
  SUBROUTINE MATRIX(A,N,ROOTS,K4A,IER)                     CBL 22860
  COMPLEX ROOTS(1)                                         CBL 22870
  DIMENSION A(7,7,3),ATILDA(7,7,15),ADET(29),           CBL 22880
1      G(7,7,15)                                           CBL 22890
  DIMENSION COEF(29),EQ(29),RR(29),RC(29),FCL(29)         CBL 22900
  COMMON/DAT/AERO(150),AEROP(50),KODE(20),LL              CBL 22910
  DO 501 I=1,29                                           CBL 22920
501 ADET(I)=0                                              CBL 22930
  ISWCK=1                                                  CBL 22940
  IW=6                                                     CBL 22950
  K=2                                                      CBL 22960
    KP1 = K + 1                                           CBL 22970
    IF(KODE(5).EQ.0) GO TO 26                             CBL 22980
    DO 25 I = 1, N                                       CBL 22990
    DO 25 J = 1, N                                       CBL 23000
    WRITE(IW, 39) I, J                                   CBL 23010
25 WRITE(IW, 50) (A(I,J,K1), K1 = 1, KP1)               CBL 23020
26 CALL SCALER(A,1.,N,N,KP1)                             CBL 23030
  CALL EQUIL(A,N,N,KP1,EQ,ODET)                           CBL 23040
  CALL ENVERT(N, A, K, G, ATILDA, ADET)                   CBL 23050
  DO 301 I=1,29                                           CBL 23060
301 COEF(I)=ADET(I)                                       CBL 23070
  DO 27 I=1,29                                           CBL 23080
27 IF(ABS(COEF(I)).LT.1.E-08) COEF(I)=0.                 CBL 23090
  IF(KODE(5).EQ.0) GO TO 305                             CBL 23100

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WRITE(1W,401)	CBL 23110
1 FORMAT(2X,'COEFFICIENTS OF CHARACTERISTIC POLYNOMIAL	CBL 23120
1 ORDERED FROM LOW TO HIGH')	CBL 23130
WRITE(1W,400)(COEF(I),I=1,29)	CBL 23140
400 FFORMAT(6(2X,E10.3))	CBL 23150
305 CONTINUE	CBL 23160
CALL PRBM1(COEF,29,RR,RC,PCL,IRT,IER,50)	CBL 23170
DO 300 I=1,IRT	CBL 23180
300 ROOTS(I)=CMPLX(RR(I),RC(I))	CBL 23190
K4A=IRT	CBL 23200
RETURN	CBL 23210
39 FORMAT(25X,3HA(,I2,IH,,I2,IH))	CBL 23220
50 FORMAT(6E19.8)	CBL 23230
END	CBL 23240
SUBROUTINE POLADD(N1,V1,N2,V2,N3,V3)	CBL 23250
C SUM OF TWO POLYNOMIALS	CBL 23260
C	CBL 23270
C N1= DEGREE OF P1 (FIRST POLYNOMIAL)	CBL 23280
C N2= DEGREE OF P2	CBL 23290
C N3= DEGREE OF OUTPUT POLYNOMIAL	CBL 23300
C	CBL 23310
C V1= BASE ADDRESS OF COEFFICIENTS OF P1	CBL 23320
C V2= BASE ADDRESS OF COEFFICIENTS OF P2	CBL 23330
C V3= BASE ADDRESS OF OUTPUT VECTOR.	CBL 23340
C	CBL 23350
C THIS ROUTINE WILL HANDLE A POLYNOMIAL OF DEGREE 50	CBL 23360
C DIMENSION V1(51),V2(51),V3(51)	CBL 23370
C PERFORM ADD --ADD COEFFICIENTS OF LIKE POWERS	CBL 23380
IC3=N2+1	CBL 23390
IC1=N1+1	CBL 23400
IC2=N2+2	CBL 23410
IC4=N1+2	CBL 23420
IF (N2-N1) 1,8,2	CBL 23430
1 DO 4 I=IC2,IC1	CBL 23440
4 V3(I)=V1(I)	CBL 23450
8 N3= N1	CBL 23460
DO 5 I=1,IC3	CBL 23470
5 V3(I)= V1(I)+V2(I)	CBL 23480
RETURN	CBL 23490
2 N3 = N2	CBL 23500
DO 6 I=1,IC1	CBL 23510
V3(I)=V1(I)+V2(I)	CBL 23520
6 CONTINUE	CBL 23530
DO 7 J=IC4,IC3	CBL 23540
V3(J)=V2(J)	CBL 23550
7 CONTINUE	CBL 23560
RETURN	CBL 23570
END	CBL 23580
SUBROUTINE POLSUB (N1,V1,N2,V2,N3,V3)	CBL 23590
C	CBL 23600
C SUBTRACT P2 FROM P1 AND STORE IN P3	CBL 23610
C	CBL 23620
C SEE NOTES ON ADD	CBL 23630
C DIMENSION V1(51),V2(51),V3(51)	CBL 23640
	CBL 23650

	IC1=N1+1	CBL 23660
	IC2=N2+1	CBL 23670
	IC3=N2+2	CBL 23680
	IC4=N1+2	CBL 23690
	IF (N2-N1) 1,8,2	CBL 23700
1	DO 4 I= IC3, IC1	CBL 23710
4	V3(I) = V1(I)	CBL 23720
8	N3=N1	CBL 23730
	DO 5 I=1, IC2	CBL 23740
5	V3(I)=V1(I)-V2(I)	CBL 23750
	RETURN	CBL 23760
2	N3=N2	CBL 23770
	DO 6 I=1, IC1	CBL 23780
	V3(I)=V1(I)-V2(I)	CBL 23790
6	CONTINUE	CBL 23800
	DO 7 J=IC4, IC2	CBL 23810
	V3(J)=-V2(J)	CBL 23820
7	CONTINUE	CBL 23830
	RETURN	CBL 23840
	END	CBL 23850
		CBL 23860
	SUBROUTINE POLMPY(N1, START1, N2, START2, N3, START3)	CBL 23870
C	MULTIPLY TWO POLYNOMIALS	CBL 23880
C	N1 = DEGREE OF P1 (THE FIRST POLYNOMIAL)	CBL 23890
C	N2 = DEGREE OF P2	CBL 23900
C	N3 = THE LOCATION (INT.) WHERE THE DEGREE OF THE OUTPUT	CBL 23910
C	POLYNOMIAL WILL BE STORED.	CBL 23920
C	START1 = THE FIRST LOCATION OF THE COEFFICIENTS OF P1 . CONSTANT	CBL 23930
C	TERM IS FIRST	CBL 23940
C	START2 = THE FIRST LOCATION OF THE COEFFICIENTS OF P2	CBL 23950
C		CBL 23960
C	START3 = THE BASE LOCATION OF THE OUTPUT POLYNOMIAL	CBL 23970
C		CBL 23980
C	THE ROUTINE WILL HANDLE POLYNOMIALS OF 50TH DEGREE	CBL 23990
C	DIMENSION START1(55), START2(55), START3(55), WORK(51)	CBL 24000
C		CBL 24010
C	START MULTIPLY -- ZERO OUTPUT VECTOR	CBL 24020
C		CBL 24030
	N4=N1+N2+1	CBL 24040
	DO 1 I=1, N4	CBL 24050
	WORK(I) = 0.0	CBL 24060
1	CONTINUE	CBL 24070
C		CBL 24080
C	CARRY THROUGH MULTIPLICATION PROCESS	CBL 24090
C		CBL 24100
	IC1 = N1+1	CBL 24110
	IC2 = N2+1	CBL 24120
	DO 3 I=1, IC1	CBL 24130
	DO 2 J=1, IC2	CBL 24140
	WORK (I+J-1) =(START1(I)* START2(J))+WORK(I+J-1)	CBL 24150
2	CONTINUE	CBL 24160
3	CONTINUE	CBL 24170
	DO 4 I=1, N4	CBL 24180
4	START3(I) = WORK(I)	CBL 24190
	N3=N4-1	CBL 24200

RETURN	CBL 24210
END	CBL 24220
SUBROUTINE MATMPY(A, N, IADEG, B, M, IBDEG, C, NA, NE, NC)	
DIMENSION A(7,7,NA),B(7,7,NB),C(7,7,NC),VA(29),VB(29),VC(29)	
1	VD(29)
IADEG1 = IADEG + 1	CBL 24230
IBDEG1 = IBDEG + 1	CBL 24240
ICDEG1 = IADEG + IBDEG + 1	CBL 24250
DO 10 I = 1, N	CBL 24260
DO 10 J = 1, M	CBL 24270
DO 50 K = 1, ICDEG1	CBL 24280
50 VD(K) = 0.0	CBL 24290
DO 20 JJ = 1, N	CBL 24300
DO 30 K = 1, IADEG1	CBL 24310
30 VA(K) = A(I,JJ,K)	CBL 24320
DO 40 K = 1, IBDEG1	CBL 24330
40 VB(K) = B(JJ,J,K)	CBL 24340
CALL POLMPY(IADEG, VA, IBDEG, VB, ICDEG, VC)	CBL 24350
20 CALL POLADD(ICDEG, VC, ICDEG, VD, ICDEG, VC)	CBL 24360
DO 60 K = 1, ICDEG1	CBL 24370
60 C(I,J,K) = VD(K)	CBL 24380
10 CONTINUE	CBL 24390
RETURN	CBL 24400
END	CBL 24410
SUBROUTINE TRACE(N, AI, IADEG, RL, F)	
DIMENSION AI(7,7,15),P(27),VA(27),VB(27)	
IADEG1 = IADEG + 1	CBL 24420
DO 50 K = 1, IADEG1	CBL 24430
50 VB(K) = 0.0	CBL 24440
DO 10 I = 1, N	CBL 24450
DO 20 K = 1, IADEG1	CBL 24460
20 VA(K) = AI(I,I,K)	CBL 24470
10 CALL POLADD(IADEG, VA, IADEG, VB, IADEG, VE)	CBL 24480
DO 30 K = 1, IADEG1	CBL 24490
30 P(K) = VB(K) / RL	CBL 24500
RETURN	CBL 24510
END	CBL 24520
SUBROUTINE COMPRI(N, IADEG, AI, P, BI)	
DIMENSION AI(7,7,15),BI(7,7,15),P(27),VA(27),VE(27)	
IADEG1 = IADEG + 1	CBL 24530
DO 10 I = 1, N	CBL 24540
DO 10 J = 1, N	CBL 24550
IF (I .NE. J) GO TO 20	CBL 24560
DO 50 K = 1, IADEG1	CBL 24570
50 VA(K) = AI(I,J,K)	CBL 24580
CALL POLSUB(IADEG, VA, IADEG, F, IADEG, VE)	CBL 24590
DO 51 K = 1, IADEG1	CBL 24600
51 BI(I,J,K) = VE(K)	CBL 24610
GO TO 10	CBL 24620
20 DO 52 K = 1, IADEG1	CBL 24630
52 BI(I,J,K) = AI(I,J,K)	CBL 24640
10 CONTINUE	CBL 24650
	CBL 24660
	CBL 24670
	CBL 24680
	CBL 24690
	CBL 24700
	CBL 24710
	CBL 24720
	CBL 24730
	CBL 24740
	CBL 24750

RETURN
END

CBL 24760
CBL 24770
CBL 24780

SUBROUTINE ENVERT(N, A, IADEG, AI, BI, F)
DIMENSION A(7,7,3),AI(7,7,15),BI(7,7,15),F(27)
IADEG1 = IADEG + 1
DO 50 I = 1, N
DO 50 J = 1, N
DO 50 K = 1, IADEG1
50 AI(I,J,K) = A(I,J,K)
IBDEG = 0
DO 10 L = 1, N
IF (L .EQ. 1) GO TO 20
CALL MATMPY (A,N,IADEG,BI,N,IBDEG,AI,3,7,7)
20 IBDEG = IBDEG + IADEG
RL = L
CALL TRACE(N, AI, IBDEG, RL, P)
IF (L .EQ. N) GO TO 30
10 CALL COMPTI(N, IBDEG, AI, P, BI)
30 CONTINUE
RETURN
END

CBL 24790
CBL 24800
CBL 24810
CBL 24820
CBL 24830
CBL 24840
CBL 24850
CBL 24860
CBL 24870
CBL 24880
CBL 24890
CBL 24900
CBL 24910
CBL 24920
CBL 24930
CBL 24940
CBL 24950
CBL 24960
CBL 24970
CBL 24980

SUBROUTINE SCALER (C,SCALE,M,N,NC)
DIMENSION C(7,7,NC)
IF(NC.LE.1) RETURN
DO 1 I=1,M
DO 1 J=1,N
DO 1 K=2,NC
1 C(I,J,K)=C(I,J,K)*SCALE**(K-1)
RETURN
END

CBL 24990
CBL 25000
CBL 25010
CBL 25020
CBL 25030
CBL 25040
CBL 25050
CBL 25060
CBL 25070
CBL 25080

SUBROUTINE EQUIL (C,M,N,NC,EQ,DDET)
DIMENSION C(7,7,NC),EQ(M)
DDET=1.0
DO 1 I=1,M
AMAX=C.000
DO 2 J=1,N
DO 2 K=1,NC
CC=ABS(C(I,J,K))
IF (CC.GT.AMAX) AMAX=CC
2 CONTINUE
EQ(I)=10./AMAX
DO 3 J=1,N
DO 3 K=1,NC
3 C(I,J,K)=C(I,J,K)*EQ(I)
1 DDET=DDET*EQ(I)
DDET=DDET*(-1)**(M-1)
RETURN
END

CBL 25090
CBL 25100
CBL 25110
CBL 25120
CBL 25130
CBL 25140
CBL 25150
CBL 25160
CBL 25170
CBL 25180
CBL 25190
CBL 25200
CBL 25210
CBL 25220
CBL 25230
CBL 25240
CBL 25250
CBL 25260
CBL 25270

.....CBL 25280
CBL 25290
CBL 25300

SUBROUTINE PRBM1

C
C
C
C

PURPOSE

TO CALCULATE ALL REAL AND COMPLEX ROOTS OF A GIVEN
POLYNOMIAL WITH REAL COEFFICIENTS.

USAGE

CALL PRBM1 (C,IC,RR,RC,POL,IR,IER,LIM)

DESCRIPTION OF PARAMETERS

C - INPUT VECTOR CONTAINING THE COEFFICIENTS OF THE
GIVEN POLYNOMIAL. COEFFICIENTS ARE ORDERED FROM
LOW TO HIGH. ON RETURN COEFFICIENTS ARE DIVIDED
BY THE LAST NONZERO TERM.

IC - DIMENSION OF VECTORS C, RR, RC, AND POL.

RR - RESULTANT VECTOR OF REAL PARTS OF THE ROOTS.

RC - RESULTANT VECTOR OF COMPLEX PARTS OF THE ROOTS.

POL - RESULTANT VECTOR OF COEFFICIENTS OF THE POLYNOMIAL
WITH CALCULATED ROOTS. COEFFICIENTS ARE ORDERED
FROM LOW TO HIGH (SEE REMARK 4).

IR - OUTPUT VALUE SPECIFYING THE NUMBER OF CALCULATED
ROOTS. NORMALLY IR IS EQUAL TO IC-1.

IER - RESULTANT ERROR PARAMETER CODED AS FOLLOWS

IER=0 - NO ERROR.

IER=1 - SUBROUTINE PQFB RECORDS POOR CONVERGENCE
AT SOME QUADRATIC FACTORIZATION WITHIN
50 ITERATION STEPS.

IER=2 - POLYNOMIAL IS DEGENERATE, I.E. ZERO OR
CONSTANT,
OR OVERFLOW IN NORMALIZATION OF GIVEN
POLYNOMIAL.

IER=3 - THE SUBROUTINE IS BYPASSED DUE TO
SUCCESSIVE ZERO DIVISORS OR OVERFLOWS
IN QUADRATIC FACTORIZATION OR DUE TO
COMPLETELY UNSATISFACTORY ACCURACY.

IER=-1 - CALCULATED COEFFICIENT VECTOR HAS LESS
THAN THREE CORRECT SIGNIFICANT DIGITS.
THIS REVEALS POOR ACCURACY OF CALCULATED
ROOTS.

LIM - NUMBER OF ITERATION STEPS, NOMINAL 50.

REMARKS

- (1) REAL PARTS OF THE ROOTS ARE STORED IN RR(1) UP TO RR(IR)
AND CORRESPONDING COMPLEX PARTS IN RC(1) UP TO RC(IR).
- (2) ERROR MESSAGE IER=1 INDICATES POOR CONVERGENCE WITHIN
50 ITERATION STEPS AT SOME QUADRATIC FACTORIZATION
PERFORMED BY SUBROUTINE PQFB.
- (3) NO ACTION BESIDES ERROR MESSAGE IER=2 IN CASE OF A ZERO
OR CONSTANT POLYNOMIAL. THE SAME ERROR MESSAGE IS GIVEN
IN CASE OF AN OVERFLOW IN NORMALIZATION OF GIVEN
POLYNOMIAL.
- (4) ERROR MESSAGE IER=3 INDICATES SUCCESSIVE ZERO DIVISORS
OR OVERFLOWS OR COMPLETELY UNSATISFACTORY ACCURACY AT
ANY QUADRATIC FACTORIZATION PERFORMED BY
SUBROUTINE PQFB. IN THIS CASE CALCULATION IS BYPASSED.
IR RECORDS THE NUMBER OF CALCULATED ROOTS.
POL(1),...,POL(J-IR) ARE THE COEFFICIENTS OF THE

C	REMAINING POLYNOMIAL, WHERE J IS THE ACTUAL NUMBER OF	CBL 25860
C	COEFFICIENTS IN VECTOR C (NORMALLY J=IC).	CBL 25870
C	(5) IF CALCULATED COEFFICIENT VECTOR HAS LESS THAN THREE	CBL 25880
C	CORRECT SIGNIFICANT DIGITS THOUGH ALL QUADRATIC	CBL 25890
C	FACTORIZATIONS SHOWED SATISFACTORY ACCURACY, THE ERROR	CBL 25900
C	MESSAGE IER=-1 IS GIVEN.	CBL 25910
C	(6) THE FINAL COMPARISON BETWEEN GIVEN AND CALCULATED	CBL 25920
C	COEFFICIENT VECTOR IS PERFORMED ONLY IF ALL ROOTS HAVE	CBL 25930
C	BEEN CALCULATED. IN THIS CASE THE NUMBER OF ROOTS IR IS	CBL 25940
C	EQUAL TO THE ACTUAL DEGREE OF THE POLYNOMIAL (NORMALLY	CBL 25950
C	IR=IC-1). THE MAXIMAL RELATIVE ERROR OF THE COEFFICIENT	CBL 25960
C	VECTOR IS RECORDED IN RR(IR+1).	CBL 25970
C		CBL 25980
C	SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED	CBL 25990
C	SUBROUTINE PQFB QUADRATIC FACTORIZATION OF A POLYNOMIAL	CBL 26000
C	BY BAIRSTOW ITERATION.	CBL 26010
C		CBL 26020
C	METHOD	CBL 26030
C	THE ROOTS OF THE POLYNOMIAL ARE CALCULATED BY MEANS OF	CBL 26040
C	SUCCESSIVE QUADRATIC FACTORIZATION PERFORMED BY BAIRSTOW	CBL 26050
C	ITERATION. X**2 IS USED AS INITIAL GUESS FOR THE FIRST	CBL 26060
C	QUADRATIC FACTOR, AND FURTHER EACH CALCULATED QUADRATIC	CBL 26070
C	FACTOR IS USED AS INITIAL GUESS FOR THE NEXT ONE. AFTER	CBL 26080
C	COMPUTATION OF ALL ROOTS THE COEFFICIENT VECTOR IS	CBL 26090
C	CALCULATED AND COMPARED WITH THE GIVEN ONE.	CBL 26100
C	FOR REFERENCE, SEE J. H. WILKINSON, THE EVALUATION OF THE	CBL 26110
C	ZEROS OF ILL-CONDITIONED POLYNOMIALS (PART ONE AND TWO),	CBL 26120
C	NUMERISCHE MATHEMATIK, VOL.1 (1959), PP.150-180.	CBL 26130
C	CBL 26140
C		CBL 26150
C	SUBROUTINE PRBM1(C,IC,RR,RC,PCL,IR,IER,LIM)	CBL 26160
C		CBL 26170
C		CBL 26180
C		CBL 26190
C	DIMENSION C(1),RR(1),RC(1),PCL(1),Q(4)	CBL 26200
C	TEST=1.E+70	CBL 26210
C		CBL 26220
C	TEST ON LEADING ZERO COEFFICIENTS	CBL 26230
C	EPS=1.E-3	CBL 26240
C	LIM=KK*LIM WHERE KK=1 OR 2 AND LIM=50.	CBL 26250
C	IR=IC+1	CBL 26260
C	1 IR=IR-1	CBL 26270
C	IF(IR-1)42,42,2	CBL 26280
C	2 IF(C(IR))3,1,3	CBL 26290
C		CBL 26300
C	WORK UP ZERO ROOTS AND NORMALIZE REMAINING POLYNOMIAL	CBL 26310
C	3 IER=0	CBL 26320
C	J=IR	CBL 26330
C	L=0	CBL 26340
C	A=C(IR)	CBL 26350
C	DO 8 I=1,IR	CBL 26360
C	IF(L)4,4,7	CBL 26370
C	4 IF(C(I))6,5,6	CBL 26380
C	5 RR(I)=0.	CBL 26390
C	RC(I)=0.	CBL 26400

POL(J)=0.	CBL 26410
J=J-1	CBL 26420
GO TO 8	CBL 26430
6 L=1	CBL 26440
IST=I	CBL 26450
J=0	CBL 26460
7 J=J+1	CBL 26470
C(I)=C(I)/A	CBL 26480
POL(J)=C(I)	CBL 26490
IF(POL(J).GT.TEST) GO TO 42	CBL 26500
8 CONTINUE	CBL 26510
C	CBL 26520
C START HAIRSTON ITERATION	CBL 26530
Q1=0.	CBL 26540
Q2=0.	CBL 26550
9 IF(J-2)33,10,14	CBL 26560
C	CBL 26570
C DEGREE OF RESTPOLYNOMIAL IS EQUAL TO ONE	CBL 26580
10 A=POL(1)	CBL 26590
PR(IST)=-A	CBL 26600
RC(IST)=0.	CBL 26610
IR=IR-1	CBL 26620
Q2=0.	CBL 26630
IF(IR-1)13,13,11	CBL 26640
11 DO 12 I=2,IR	CBL 26650
Q1=Q2	CBL 26660
Q2=POL(I+1)	CBL 26670
12 POL(I)=A*Q2+Q1	CBL 26680
13 POL(IR+1)=A+Q2	CBL 26690
GO TO 34	CBL 26700
C THIS IS BRANCH TO COMPARISON OF COEFFICIENT VECTORS C AND POL	CBL 26710
C	CBL 26720
C DEGREE OF RESTPOLYNOMIAL IS GREATER THAN ONE	CBL 26730
14 DO 22 L=1,10	CBL 26740
N=1	CBL 26750
15 Q(1)=Q1	CBL 26760
Q(2)=Q2	CBL 26770
CALL PQFB1(POL,J,Q,LIM,I)	CBL 26780
IF(I)16,24,23	CBL 26790
16 IF(Q1)18,17,18	CBL 26800
17 IF(Q2)18,21,18	CBL 26810
18 GO TO (19,20,19,21).N	CBL 26820
19 Q1=-Q1	CBL 26830
N=N+1	CBL 26840
GO TO 15	CBL 26850
20 Q2=-Q2	CBL 26860
N=N+1	CBL 26870
GO TO 15	CBL 26880
21 Q1=1.+Q1	CBL 26890
22 Q2=1.-Q2	CBL 26900
C	CBL 26910
C ERROR EXIT DUE TO UNSATISFACTORY RESULTS OF FACTORIZATION	CBL 26920
IFR=3	CBL 26930
IR=IR-J	CBL 26940
RETURN	CBL 26950

C		CBL 26960
C	WORK UP RESULTS OF QUADRATIC FACTORIZATION	CBL 26970
	23 IER=1	CBL 26980
	24 Q1=Q(1)	CBL 26990
	Q2=Q(2)	CBL 27000
C		CBL 27010
C	PERFORM DIVISION OF FACTORIZED POLYNOMIAL BY QUADRATIC FACTOR	CBL 27020
	R=0.	CBL 27030
	A=0.	CBL 27040
	I=J	CBL 27050
	25 H=-Q1*B-Q2*A+POL(I)	CBL 27060
	POL(I)=B	CBL 27070
	B=A	CBL 27080
	A=H	CBL 27090
	I=I-1	CBL 27100
	IF(I-2)26,26,25	CBL 27110
	26 POL(2)=B	CBL 27120
	POL(1)=A	CBL 27130
C		CBL 27140
C	MULTIPLY POLYNOMIAL WITH CALCULATED ROOTS BY QUADRATIC FACTOR	CBL 27150
	L=IR-1	CBL 27160
	IF(J-L)27,27,25	CBL 27170
	27 DO 28 I=J,L	CBL 27180
	28 POL(I-1)=POL(I-1)+POL(I)*Q2+POL(I+1)*Q1	CBL 27190
	29 POL(L)=POL(L)+POL(L+1)*Q2+Q1	CBL 27200
	POL(IR)=POL(IR)+Q2	CBL 27210
C		CBL 27220
C	CALCULATE ROOT-PAIR FROM QUADRATIC FACTOR $X^2+Q2*X+Q1$	CBL 27230
	H=-.5*Q2	CBL 27240
	A=H*H-Q1	CBL 27250
	B=SQRT(ABS(A))	CBL 27260
	IF(A)30,30,31	CBL 27270
	30 RR(IST)=H	CBL 27280
	RC(IST)=B	CBL 27290
	IST=IST+1	CBL 27300
	RR(IST)=H	CBL 27310
	RC(IST)=-B	CBL 27320
	GO TO 32	CBL 27330
	31 B=H+SIGN(B,H)	CBL 27340
	RR(IST)=Q1/B	CBL 27350
	RC(IST)=0.	CBL 27360
	IST=IST+1	CBL 27370
	RR(IST)=B	CBL 27380
	RC(IST)=0.	CBL 27390
	32 IST=IST+1	CBL 27400
	J=J-2	CBL 27410
	GO TO 9	CBL 27420
C		CBL 27430
C	SHIFT BACK ELEMENTS OF POL BY 1 AND COEFFICIENTS POL AND C	CBL 27440
	33 IR=IR-1	CBL 27450
	34 A=0.	CBL 27460
	DO 35 I=1,IR	CBL 27470
	Q1=C(I)	CBL 27480
	Q2=POL(I+1)	CBL 27490
	POL(I)=Q2	CBL 27500

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      IF(Q1)35,36,35                                CBL 27510
35  Q2=(Q1-Q2)/Q1                                    CBL 27520
36  Q2=ABS(Q2)                                        CBL 27530
      IF(Q2-A)38,38,37                                CBL 27540
37  A=Q2                                              CBL 27550
38  CONTINUE                                          CBL 27560
      I=IR+1                                           CBL 27570
      POL(I)=1.                                        CBL 27580
      RR(I)=A                                          CBL 27590
      RC(I)=0.                                        CBL 27600
      IF(IER)39,39,41                                CBL 27610
39  IF(A-EPS)41,41,40                                CBL 27620
C                                                    CBL 27630
C      WARNING DUE TO POOR ACCURACY OF CALCULATED COEFFICIENT VECTOR CBL 27640
40  IER=-1                                           CBL 27650
41  RETURN                                           CBL 27660
C                                                    CBL 27670
C      ERROR EXIT DUE TO DEGENERATE POLYNOMIAL OR OVERFLOW IN CBL 27680
C      NORMALIZATION                                CBL 27690
42  IFR=2                                           CBL 27700
      IR=0                                           CBL 27710
      RETURN                                         CBL 27720
      END                                           CBL 27730
C                                                    CBL 27740
C                                                    CBL 27750
C ..... CBL 27760
C                                                    CBL 27770
C      SUBROUTINE PQFB1                                CBL 27780
C                                                    CBL 27790
C      PURPOSE                                         CBL 28000
C      TO FIND AN APPROXIMATION  $Q(X)=Q1+Q2X+X^2X$  TO A QUADRATIC CBL 27810
C      FACTOR OF A GIVEN POLYNOMIAL  $P(X)$  WITH REAL COEFFICIENTS. CBL 27820
C                                                    CBL 27830
C      USAGE                                           CBL 27840
C      CALL PQFB1(C,IC,Q,LIM,IER)                    CBL 27850
C                                                    CBL 27860
C      DESCRIPTION OF PARAMETERS                      CBL 27870
C      C - INPUT VECTOR CONTAINING THE COEFFICIENTS OF  $P(X)$  - CBL 27880
C           C(1) IS THE CONSTANT TERM (DIMENSION IC) CBL 27890
C      IC - DIMENSION OF C                            CBL 27900
C      Q - VECTOR OF DIMENSION 4 - ON INPUT Q(1) AND Q(2) MUST CBL 27910
C           CONTAIN INITIAL GUESSES FOR Q1 AND Q2 - ON RETURN Q(1) CBL 27920
C           AND Q(2) CONTAIN THE REFINED COEFFICIENTS Q1 AND Q2 OF CBL 27930
C            $Q(X)$ , WHILE Q(3) AND Q(4) CONTAIN THE COEFFICIENTS A CBL 27940
C           AND B OF  $A+B*X$ , WHICH IS THE REMAINDER OF THE QUOTIENT CBL 27950
C           OF  $P(X)$  BY  $Q(X)$  CBL 27960
C      LIM - INPUT VALUE SPECIFYING THE MAXIMUM NUMBER OF CBL 27970
C            ITERATIONS TO BE PERFORMED CBL 27980
C      IER - RESULTING ERROR PARAMETER (SEE REMARKS) CBL 27990
C            IER= 0 - NO ERROR CBL 28000
C            IER= 1 - NO CONVERGENCE WITHIN LIM ITERATIONS CBL 28010
C            IER=-1 - THE POLYNOMIAL  $P(X)$  IS CONSTANT OR UNDEFINED CBL 28020
C                     - OR OVERFLOW OCCURRED IN NORMALIZING  $P(X)$  CBL 28030
C            IER=-2 - THE POLYNOMIAL  $P(X)$  IS OF DEGREE 1 CBL 28040
C            IER=-3 - NO FURTHER REFINEMENT OF THE APPROXIMATION TO CBL 28050

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A QUADRATIC FACTOR IS FEASIBLE, DUE TO EITHER
DIVISION BY 0, OVERFLOW OF AN INITIAL GUESS
THAT IS NOT SUFFICIENTLY CLOSE TO A FACTOR OF
P(X)

REMARKS

- (1) IF IER=-1 THERE IS NO COMPUTATION OTHER THAN THE
POSSIBLE NORMALIZATION OF C.
- (2) IF IER=-2 THERE IS NO COMPUTATION OTHER THAN THE
NORMALIZATION OF C.
- (3) IF IER=-3 IT IS SUGGESTED THAT A NEW INITIAL GUESS BE
MADE FOR A QUADRATIC FACTOR. C, HOWEVER, WILL CONTAIN
THE VALUES ASSOCIATED WITH THE ITERATION THAT YIELDED
THE SMALLEST NORM OF THE MODIFIED LINEAR REMAINDER.
- (4) IF IER=1, THEN, ALTHOUGH THE NUMBER OF ITERATIONS LIM
WAS TOO SMALL TO INDICATE CONVERGENCE, NO OTHER PROBLEMS
HAVE BEEN DETECTED, AND C WILL CONTAIN THE VALUES
ASSOCIATED WITH THE ITERATION THAT YIELDED THE SMALLEST
NORM OF THE MODIFIED LINEAR REMAINDER.
- (5) FOR COMPLETE DETAIL SEE THE DOCUMENTATION FOR
SUBROUTINES PQFB AND DPQFB.

SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
NONE

METHOD

COMPUTATION IS BASED ON BAIRSTOW'S ITERATIVE METHOD. (SEE
WILKINSON, J.H., THE EVALUATION OF THE ZEROS OF ILL-CON-
DITIONED POLYNOMIALS (PART ONE AND TWO), NUMERISCHE MATHE-
MATIK, VOL.1 (1959), PP. 150-180, OF HILDEBRAND, F.B.,
INTRODUCTION TO NUMERICAL ANALYSIS, MC GRAW-HILL, NEW YORK/
TORONTO/LONDON, 1956, PP. 472-476.)

.....
SUBROUTINE PQFB1(C,IC,Q,LIM,IER)

DIMENSION C(4),Q(4)

TEST ON LEADING ZERO COEFFICIENTS

IER=0

TEST=1.E+70

J=IC+1

1 J=J-1

IF(J-1)40,40,2

2 IF(C(J))3,1,3

NORMALIZATION OF REMAINING COEFFICIENTS

3 A=C(J)

IF(A-1.)4,6,4

4 DO 5 I=1,J

C(I)=C(I)/A

IF(C(I).GT.TEST) GO TO 40

5 CONTINUE

C		CBL 28610
C	TEST ON NECESSITY OF BAIRSTOW ITERATION	CBL 28620
-	6 IF(J-3)41,38,7	CBL 28630
C		CBL 28640
C	PREPARE BAIRSTOW ITERATION	CBL 28650
	7 EPS = 1.E-4	CBL 28660
	EPS1= 1.E-2	CBL 28670
	L=0	CBL 28680
	LL=0	CBL 28690
	Q1=Q(1)	CBL 28700
	Q2=Q(2)	CBL 28710
	QQ1=C.	CBL 28720
	QQ2=C.	CBL 28730
	AA=C(1)	CBL 28740
	BB=C(2)	CBL 28750
	CR=ABS(AA)	CBL 28760
	CA=ABS(BB)	CBL 28770
	IF(CB-CA)8,9,10	CBL 28780
	8 CC=CB+CB	CBL 28790
	CB=CB/CA	CBL 28800
	CA=1.	CBL 28810
	GJ TO 11	CBL 28820
	9 CC=CA+CA	CBL 28830
	CA=1.	CBL 28840
	CB=1.	CBL 28850
	GJ TO 11	CBL 28860
	10 CC=CA+CA	CBL 28870
	CA=CA/CB	CBL 28880
	CB=1.	CBL 28890
	11 CD=CC*.1	CBL 28900
C		CBL 28910
C	START BAIRSTOW ITERATION	CBL 28920
C	PREPARE NESTED MULTIPLICATION	CBL 28930
	12 A=0.	CBL 28940
	R=A	CBL 28950
	A1=A	CBL 28960
	B1=A	CBL 28970
	I=J	CBL 28980
	QQQ1=Q1	CBL 28990
	QQQ2=Q2	CBL 29000
	DQ1=FH	CBL 29010
	DQ2=F	CBL 29020
C		CBL 29030
C	START NESTED MULTIPLICATION	CBL 29040
	13 H=-Q1*B-Q2*A+C(I)	CBL 29050
	IF(F.GT.TEST) GO TO 42	CBL 29060
	B=A	CBL 29070
	A=F	CBL 29080
	I=I-1	CBL 29090
	IF(I-1)18,15,16	CBL 29100
	15 H=C.	CBL 29110
	16 H=-Q1*B1-Q2*A1+H	CBL 29120
	IF(F.GT.TEST) GO TO 42	CBL 29130
	C1=R1	CBL 29140
	R1=A1	CBL 29150

A1=F	CBL 29160
GO TO 13	CBL 29170
C END OF NESTED MULTIPLICATION	CBL 29180
C	CBL 29190
C TEST ON SATISFACTORY ACCURACY	CBL 29200
18 H=CA*ABS(A)+CB*ABS(B)	CBL 29210
IF(LL)19,19,39	CBL 29220
19 L=L+1	CBL 29230
IF(ABS(A)-EPS*ABS(C(1)))20,20,21	CBL 29240
20 IF(ABS(B)-EPS*ABS(C(2)))39,39,21	CBL 29250
C	CBL 29260
C TEST ON LINEAR REMAINDER OF MINIMUM NCFM	CBL 29270
21 IF(H-CC)22,22,23	CBL 29280
22 AA=A	CBL 29290
BB=B	CBL 29300
CC=F	CBL 29310
QQ1=Q1	CBL 29320
QQ2=Q2	CBL 29330
C	CBL 29340
C TEST ON LAST ITERATION STEP	CBL 29350
23 IF(L-LIM)28,28,24	CBL 29360
C	CBL 29370
C TEST ON RESTART OF BAIRSTON ITERATION WITH ZERO INITIAL GUESS	CBL 29380
24 IF(H-CD)43,43,25	CBL 29390
25 IF(Q(1))27,26,27	CBL 29400
26 IF(Q(2))27,42,27	CBL 29410
27 Q(1)=0.	CBL 29420
Q(2)=0.	CBL 29430
GO TO 7	CBL 29440
C	CBL 29450
C PERFORM ITERATION STEP	CBL 29460
28 H1=ABS(A1)	CBL 29470
H2=ABS(B1)	CBL 29480
IF(F1-F2)45,46,46	CBL 29490
45 H1=ABS(C1)	CBL 29500
IF(F1-F2)47,48,48	CBL 29510
46 H2=ABS(C1)	CBL 29520
IF(F1-F2)46,49,49	CBL 29530
47 HH=ABS(R1)	CBL 29540
GO TO 50	CBL 29550
48 HH=ABS(C1)	CBL 29560
GO TO 50	CBL 29570
49 HH=ABS(A1)	CBL 29580
50 IF(FH)42,42,29	CBL 29590
29 A1=A1/FH	CBL 29600
B1=B1/FH	CBL 29610
C1=C1/FH	CBL 29620
H=A1*C1-B1*R1	CBL 29630
IF(F)30,42,30	CBL 29640
30 A=A/FH	CBL 29650
B=B/FH	CBL 29660
HH=(B*A1-A*B1)/H	CBL 29670
H=(A*C1-B*R1)/H	CBL 29680
Q1=Q1+FH	CBL 29690
Q2=Q2+H	CBL 29700

C	END OF ITERATION STEP	CBL 29710
C		CBL 29720
C	TEST ON SATISFACTORY RELATIVE ERROR OF ITERATED VALUES	CBL 29730
	IF(ABS(HH)-EPS*ABS(Q1))31,31,33	CBL 29740
31	IF(ABS(H)-EPS*ABS(Q2))32,32,33	CBL 29750
32	LL=1	CBL 29760
	GO TO 12	CBL 29770
C		CBL 29780
C	TEST ON DECREASING RELATIVE ERRORS	CBL 29790
33	IF(L-1)12,12,34	CBL 29800
34	IF(ABS(HH)-EPS1*ABS(Q1))35,35,12	CBL 29810
35	IF(ABS(H)-EPS1*ABS(Q2))36,36,12	CBL 29820
36	IF(ABS(QQ1*HH)-ABS(Q1*DQ1))37,44,44	CBL 29830
37	IF(ABS(QQ2*H)-ABS(Q2*DQ2))12,44,44	CBL 29840
C	END OF BAIRSTON ITERATION	CBL 29850
C		CBL 29860
C	EXIT IN CASE OF QUADRATIC POLYNOMIAL	CBL 29870
38	Q(1)=C(1)	CBL 29880
	Q(2)=C(2)	CBL 29890
	Q(3)=0.	CBL 29900
	Q(4)=0.	CBL 29910
	RETURN	CBL 29920
C		CBL 29930
C	EXIT IN CASE OF SUFFICIENT ACCURACY	CBL 29940
39	Q(1)=Q1	CBL 29950
	Q(2)=Q2	CBL 29960
	Q(3)=A	CBL 29970
	Q(4)=B	CBL 29980
	RETURN	CBL 29990
C		CBL 30000
C	ERROR EXIT IN CASE OF ZERO OR CONSTANT POLYNOMIAL	CBL 30010
40	IER=-1	CBL 30020
	RETURN	CBL 30030
C		CBL 30040
C	ERROR EXIT IN CASE OF LINEAR POLYNOMIAL	CBL 30050
41	IER=-2	CBL 30060
	RETURN	CBL 30070
C		CBL 30080
C	ERROR EXIT IN CASE OF NONREFINED QUADRATIC FACTOR	CBL 30090
42	IER=-3	CBL 30100
	GO TO 44	CBL 30110
C		CBL 30120
C	ERROR EXIT IN CASE OF UNSATISFACTORY ACCURACY	CBL 30130
43	IER=1	CBL 30140
44	Q(1)=QQ1	CBL 30150
	Q(2)=QQ2	CBL 30160
	Q(3)=AA	CBL 30170
	Q(4)=BB	CBL 30180
	RETURN	CBL 30190
	END	CBL 30200